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PSYCHOLOGY IN INDUSTRY

J. Stanley Gray
Professor of Psychology
University of Georgia

FIRST EDITION

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PSYCHOLOGY IN INDUSTRY

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PREFACE

This book is about the activities of workmen in industrial situations. It is a psychology of workmen. It is concerned with those factors which affect workmen and the efficiency of their production efforts. Some of these factors are not usually considered to be within the legitimate field of industrial psychology. The criteria which determined their inclusion in this book were the degree to which they affected men at work and the information available about them. For example, a chapter on nutrition is included because workmen are definitely affected by what they eat, and there was enough useful information available to justify its review. The author believes that any factor which affects the production efforts of workmen is appropriately classified as industrial psychology, and anything that is known about it should be reported in a textbook on industrial psychology.

The introductory chapter reviews some of the basic facts necessary to any understanding of the psychology of work. The nature of the work curve, methods of measuring work, physiological cost of work, the nature of fatigue, and the meaning of efficiency, are all discussed. Subsequent chapters each discuss some factor which affects the efficiency of men at work. Typical research is reviewed and implications suggested relative to each factor. References for further reading have been carefully selected.

This book is an introduction to industrial psychology but it is based on an elementary acquaintance with general psychology and industrial situations. Prerequisite to its use should be elementary psychology and occupational information. The latter can be waived for those who have had equivalent work experience.

While this book is intended for classroom use, it can be useful to the general reader who knows a little about psychology and a little about industry. The personnel man in a typical industry can use it as a reference book when facts concerning some specific problem are desired. *Psychology in Industry* is written for the man on the job as well as for the student who is a potential man on the job.

The author contracted three major obligations in the preparation of this book. He is first obligated to the many researchers whose material make up the major content. Some was used directly as reported and some was modified. Second, he is obligated to his colleague, Dr. Karl Garrison, who kindly prepared the last three chapters. The excellence of his contribution speaks for itself. A final obligation is to one who has long been a partner in enterprises often remote from her own interests—Dr. Gunborg Berglund-Gray. Both directly and indirectly, her participation in the making of this book has been more valuable than can be easily described.

J. STANLEY GRAY

ATHENS, GA.
November, 1951

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Chapter 1

INTRODUCTION—BASIC CONCEPTS IN HUMAN ENGINEERING

- The Amount of Work
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    - Rest
    - Spurts
    - Irregularity
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    - Individual Differences
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    - Blood Count
  - Amount and Quality of Production
    - Amount of Product
    - Quality of Product
  - Merit Rating
- Fatigue from Work
  - Physiological Fatigue
    - Muscle Fatigue
    - Nervous Fatigue
  - Psychological Fatigue
  - Reduced Output
- The Efficiency of Work
- Summary

In 1949, there was a civilian labor force of 62,105,000 in the United States, a military force of 1,466,000, and an unemployed group of 3,395,000. More than 8 million of the civilian employed group were engaged in agriculture, 14 million were in manufacturing, 9½ million were in trade and distribution, almost 6 million were in government service, 1¾ million were in financial occupations, 4¾ million were in service occupations, another 4 million were in transportation and public-utility work, 932,000 were in mining, 2 million were in construction work, and the rest were in miscellaneous activities. This labor force produced 24 billion dollars' worth of durable goods and 98 billion dollars' worth of nondurable goods. For this they were paid 56.4 billion dollars in wages and salaries. The gross national income for 1949 was 216.8 billion dollars.

These figures are quoted here because they indicate the fundamental importance of *work* in our American way of life. They suggest that work is important enough to deserve careful analysis and study. Efforts to improve its efficiency obviously affect the welfare of a large proportion of our population.

It is interesting to note that, in spite of the advanced stage of modern technological progress, our social structure makes it necessary for us to spend approximately one-third of our lives earning enough money to obtain adequate food, clothing, and shelter. Few primitive people devote more time to work than does civilized man. This is due in part to special privileges and exploitation of the working man, in part to higher standards of living and increased rate of consumption, and in part to the inefficient expenditure of human effort in work. A day's work at any level of complexity (whether common labor, semiskilled, skilled, managerial, or professional) should accomplish a great deal more and cost less in fatigue than it does now. Machines are far more efficient today than human beings. We should devote more attention to work and efficiency.

Work is defined technically as the function of a force moving an object through space. Its amount is indicated by foot-pounds, *i.e.*, the product of the distance the object is moved times the weight of the object. A ditch-digger who moves a ton of dirt an average height of 6 ft. has done work amounting to 12,000 ft.-lb. (2,000 × 6). The capacity to do work is called *energy*. A ton of dirt 6 ft. above the earth's surface has 12,000 ft.-lb. of energy. (This is *potential* energy as distinguished from *kinetic* energy, or that which is a consequence of velocity.) However, 12,000 ft.-lb. of energy cannot accomplish 12,000 ft-lb. of work because of the *friction* involved. A part of any energy expended is necessary to overcome friction. With a given amount of energy, the greater the friction, the less the work. Friction is any resistance to the free movement of mass through space.[1]

---

[1] Though friction limits the amount of work a given amount of energy can

Sometimes it is possible to change the *method* of moving an object through space and thereby to gain in advantage (see Chap. 6). For example, a 10-lb. force cannot directly lift a 20-lb. weight, but if a lever is used, a 10-lb. force can lift even a 100-lb. weight. Such devices of advantage are called *machines.* (Wheels are variations of lever action.)

Work may be performed both by machines and by human beings or workmen or "hands." That field of special study of work as performed by machines is called *engineering*—mechanical, electrical, chemical, etc.

TABLE 1–1. ENERGY CONTENT OF VARIOUS COMMON FOODS*
(In Calories per 100 g.)

Vegetables		Meats	
Beans, baked	132	Bacon	646
Beets	47	Beef, corned	308
Cabbage	32	Beef, steak	255
Carrots	46	Chicken	111
Corn (canned)	115	Egg, white	52
Eggplant	250	Egg, yolk	374
Lettuce	20	Ham	275
Mushrooms	46	Oysters	52
Onions	50	Pork sausage	469
Peas, green	103	Whitefish	154
Potatoes	85	Dairy Products	
Spinach	25	Butter	765
Tomatoes	23	Cheese, American	455
Turnips	40	Cheese, cottage	113
Fruits		Cheese, Swiss	444
Apples	65	Cream	201
Avocados	226	Milk, whole	71
Dates, dried	356	Cereals	
Muskmelon	42	Bread, white	268
Prunes	377	Hominy	364
Raisins	353	Oatmeal	410
Strawberries	130		

* From Nutritional Charts, H. J. Heinz Co., Pittsburgh, Pa.

That field of special study of work as performed by people is called *human engineering* or *industrial psychology.* This book concerns the latter field of work specialization. It is a psychology of workers, or a study of certain factors which affect workers in the procedure of processing materials. It is a book about the human factor in industry.

---

accomplish, it is of greatest value in daily life. If it were not for friction, nails and screws would not hold, ropes could not be made, movement could not be stopped—in fact, we could not walk down the street.

When the energy to accomplish work is produced by the human body (or any other organism) it is made possible by virtue of a chemical action called *metabolism*. Food, containing a definite amount of potential energy, is digested and transformed into muscle action. The unit of measurement of this energy transformation (metabolism) is the large calorie, or the amount of heat required to raise the temperature of a kilogram of water one degree centigrade. Various foods have various energy values. One gram (g.) of sugar produces 4 Calories (Cal.), 1 g. of alcohol produces 7 Cal., and 1 g. of fat produces 9.3 Cal. (See Table 1–1 for energy values of other foods.) The greater the amount of muscular action, the greater the amount of food necessary to produce the required energy. For example, sitting still requires about 100 Cal. per hour, walking about 200 per hour, and running about 500 per hour (see Table 1–2).

TABLE 1–2. ENERGY EXPENDITURE DURING VARIOUS ACTIVITIES*
(In Calories per hour)

Activity	Calories per lb.	Calories per 150-lb. man	Activity	Calories per lb.	Calories per 150-lb. man
Sleeping	0.43	65	Ironing (5-lb. iron)	0.93	144
Awake, lying still	0.50	77	Dishwashing	0.93	144
Sitting at rest	0.65	100	Sweeping floor	1.09	169
Reading aloud	0.69	105	Bookbinding	1.10	170
Standing relaxed	0.69	105	Shoemaking	1.17	180
Hand sewing	0.72	111	Walking slowly	1.30	200
Standing at attention	0.74	115	Active exercise	1.88	290
Knitting	0.75	116	Stone making	2.60	400
Dressing and undressing	0.76	118	Sawing wood	3.12	480
Singing	0.79	122	Swimming	3.25	500
Tailoring	0.88	135	Running	3.70	570
Typewriting	0.91	140	Walking very fast	4.22	650

* From Bridges, M. A., *Food and Beverage Analyses*, Lea & Febiger, Philadelphia, 1935.

Sometimes a pseudo distinction is made between physical and mental work. Shoveling coal is called physical work, and solving problems in arithmetic is called mental work. However, this distinction is one of degree and not of kind. Shoveling coal and solving problems both involve neuromuscular function which consumes calories of heat. The former activity involves the action of the great muscles of the arms, legs, and back, while the latter involves the more delicate muscles of the speech mechanism. Mental work and physical work are both governed by the same basic principles of organic function.

The study of work performed by workmen is even more important than the study of work performed by machines because machines are constructed and controlled by workmen. Some machines are almost automatic, but their continued function is dependent on how well they are cared for. Even the most automatic machine will be affected sometime by some workman.

The science of mechanical engineering is recognized and used wherever machinery is in operation. The industrialist purchases a machine with great care, has it installed only by well-trained specialists, spends money liberally in keeping it in the best operating condition, and protects it from any factors which might reduce its efficiency or shorten its duration of usefulness.

The science of human engineering (industrial psychology) is not so well recognized and is too seldom used where workmen are employed. The typical industrialist does not select his workmen with the greatest care, does not install them in their jobs with the best training, does not spend money liberally in keeping them in the best operating condition, and does not protect them from those factors which may reduce their efficiency or shorten the duration of their usefulness. In other words, the typical industrialist is a much better manager of machines than he is of men. One reason is that he knows machines better than he knows men. He can read and understand books about machines more easily than he can read and understand books about workmen. He can hire human engineers. Furthermore, in spite of the cost of labor turnover, he can change workmen more cheaply and easily than he can change machines. Human engineering or industrial psychology has been neglected in typical American industry.

Before a study can be made of factors which affect workmen, it is necessary to review briefly some basic concepts about the nature of work, the measurement of work, the nature of fatigue, and the nature of efficiency. These basic concepts are introductory to a more complete consideration of them in relation to factors which affect men at work.

THE AMOUNT OF WORK

When work is performed, its amount, the speed with which it is performed, its difficulty, the duration of time before it causes exhaustion, its frequency, and the rate of fatigue it produces may all be plotted on graphs. These are called "work curves." All work curves show at least two characteristics of work. Some show many more. The following characteristics of work curves are illustrated in accompanying figures.

Work Decrement. When the force which moves an object is kept constant (*e.g.*, the contraction of biceps in an individual's arm) and the weight moved is kept constant, the distance through which the weight is moved will diminish with repetition. Thus, if an 18-lb. weight is lifted from a position of arm's length downward to a position of arm's length upward (above the shoulder) over and over again, the activity will soon be characterized by a reduction in distance from maximum height to positions of lesser and lesser height until finally the weight cannot be lifted above the level of the completely extended arm downward. When the distance is recorded for each frequency of movement and the data put in graphic form, they resemble Fig. 1–1. This is a *work curve* and shows (1) the amount of work done (2) for a given duration of time. Note that it is characterized by a progressive decrease in amount. This, then, is the first principle of work—it reduces the ability to do more work.

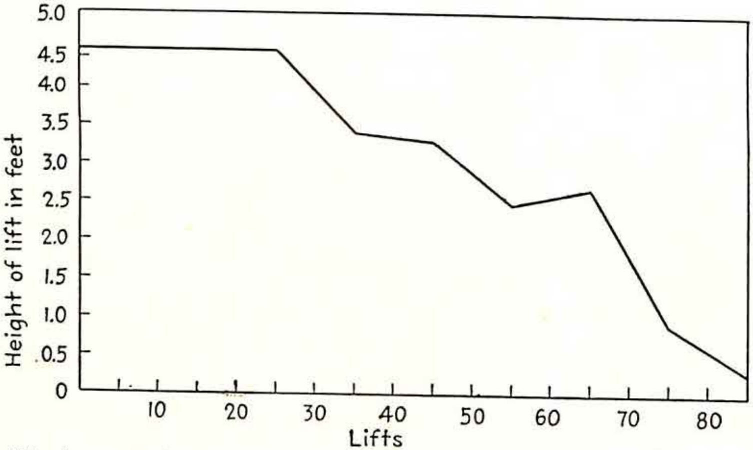

FIG. 1–1. Work curve for lifting 18-lb. weight from arm's length below shoulder to arm's length above shoulder.

Rest. After a period of rest, it is possible to perform the work again as before, although the work decrement usually begins earlier (unless the rest period is long enough for complete recovery). The effect of a 5-minute rest period on a work curve is illustrated in Fig. 1–2. The second principle of work is that rest enables the worker to recover from the effects of work. This characteristic is further discussed in Chap. 6 in this book.

Spurts. Work curves are often characterized by initial spurts or "warming-up effects." Athletes usually "warm up" before going into a baseball game, so that they can enter the game at the top of the work spurt. The effects of such a warming-up period are illustrated in Fig. 1–3. However, many work curves show no such warming-up period. Work curves often show interim spurts. One of these is obvious in Fig. 1–1. Such spurts are due to various factors but often to the realization of reduced output and a consequent increased effort. As motivation varies in intensity, work varies in amount.

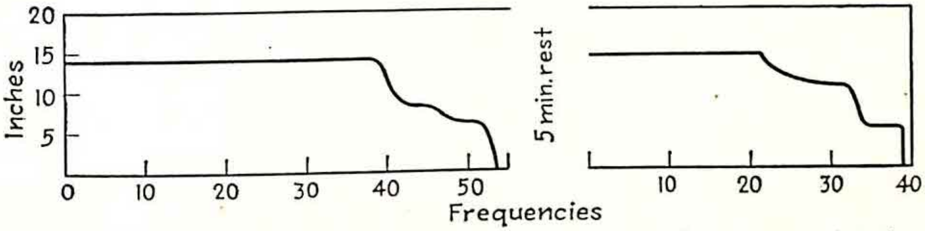

FIG. 1–2. Work curves for left hand before and after a 5-minute rest period (one subject, one trial).

If the end of the work period is known to be approaching, there is often an "end spurt" which sometimes equals the level of top production. There is a slight end spurt in the work curve shown in Fig. 1–3. (The approaching end was announced at the ninth period.) Athletes frequently pace their efforts so that energy will remain for an end spurt. Jockeys try to do the same thing in horse races.

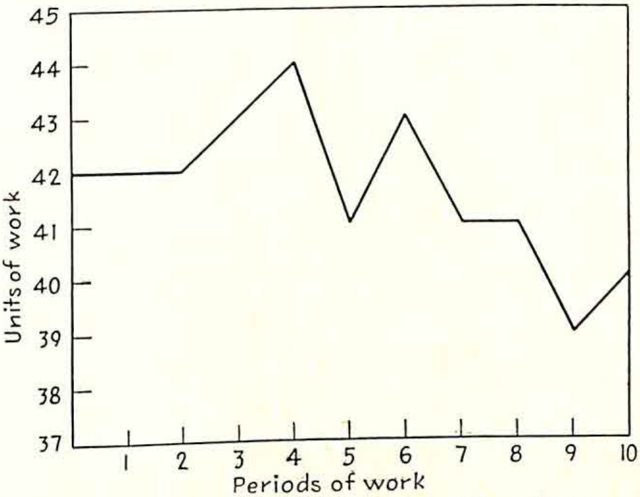

FIG. 1–3. Composite work curve for 29 workmen.

Irregularity. Another characteristic of work curves is that they are irregular. Note the fluctuations in performance in the work curves shown in Figs. 1–1 and 1–3. This is likewise obvious in the data given in Table 1–4. Unlike the regularity of machine operation, human work is erratic and unsteady. Sometimes this irregularity occurs in cycles. There is a periodicity in the fluctuation. Such cycles are sometimes spread over days and even weeks. They are probably caused by boredom followed first by a realization of low production and then by increased motivation.

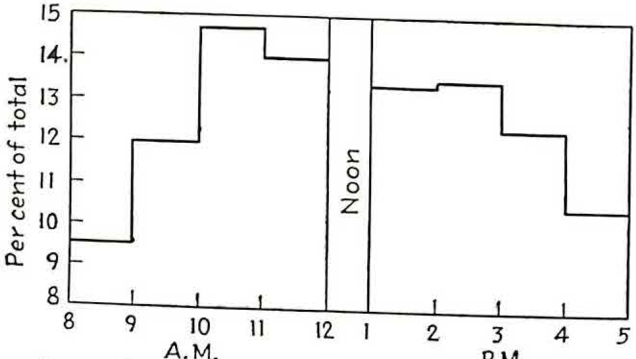

FIG. 1–4. Composite work curve for 8-hour day in a textile mill. (Data for 1950.)

Diurnal Differences. The daily work curve varies somewhat with the type of work being done and with the individual doing it. Figure 1–4 shows morning and afternoon work curves, in terms of per cent of total output, for work in a textile mill. Table 1–3 shows the ratio of production in the afternoon to that in the morning for a number of jobs in four different types of work. The differences on jobs of the same type indicate that no generalizations can be made which would be applicable to all types of work and in all situations.

TABLE 1–3. RELATION OF AFTERNOON TO MORNING OUTPUT OF WORKERS IN AN AUTOMOBILE PLANT

Type of work	P.M. output in per cent of A.M. output (separate jobs)	Mean	Range
Dexterous handwork	97, 96, 99, 97	97	3
Muscular handwork	100, 100, 89, 97, 90	95	11
Lathe machine work	104, 107, 98, 99, 102, 102	102	9
Miscellaneous machine work	101, 100, 101, 100, 108, 104, 95, 102	101	13

Individual Differences. It is suggested above that work curves vary with different individuals. Table 1–4 shows the work done by seven individuals, all performing exactly the same manual work at exactly

TABLE 1–4. CONTINUOUS WORK PRODUCED BY SEVEN INDIVIDUALS IN 10 EQUAL TIME PERIODS

Time periods	Workers						
	A	B	C	D	E	F	G
1	49	32	44	41	37	45	42
2	46	32	45	45	37	49	44
3	46	31	45	44	35	49	43
4	43	31	44	42	33	52	45
5	44	31	42	43	37	46	43
6	44	31	42	43	37	46	43
7	43	29	42	38	29	42	42
8	39	32	39	39	37	45	42
9	38	28	37	43	39	43	42
10	37	30	36	41	33	47	43
Average	42.8	30.7	41.7	41.6	36	46.7	42.9

the same time. B was a girl and the others were men. There were different levels of performance, different spurt locations, and different patterns of work decrement. (These are all more obvious when the data are plotted in work curves. This is a worth-while class exercise.)

Days of Week. Days of the week vary somewhat in output. The weekly curve is not a straight line across the graph, but a fluctuating one. Table 1–5 shows the daily output for four kinds of work. In three of them, Wednesday was the best production day, but the bobbin winders did better on Saturday. Laird[2] found that college students were most efficient in mental work (comprehension, code substitution, reading, memory of words and ideas, and addition) on Wednesday. Each day's performance in relation to the weekly average (100 per cent) was as follows: Monday 99, Tuesday, 105, Wednesday 108, Thursday 96, Friday, 97, and Saturday 95. An old study of Richter, quoted by Viteles,[3] indicates that

TABLE 1–5. DAILY OUTPUT VARIATIONS IN RELATION TO WEEKLY AVERAGE

Type of work	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Sun.
Button sewers	98.1	100.6	101.6	101.1	98.6		
Blast-furnace men	96	100	105	103	101	101	94
Weavers	96	98.9	102.6	99.3	101.2	102.1	
Bobbin winders	94.6	96.7	97.6	105.4	96.3	109.4	

---

[2] Laird, D. A., Relative Performance of College Students as Conditioned by Time of Day and Day of Week," *J. Exp. Psychol.*, 1925, 8, 50–63.

[3] Viteles, M. S., *Industrial Psychology*, p. 449, W. W. Norton & Company, New York, 1932.

Saturday is the most productive day, with Wednesday, Friday, Thursday, Tuesday, and Monday following in the order named. The composite daily output for each day of the work week for certain jobs in a textile mill is shown in Fig. 1–5.

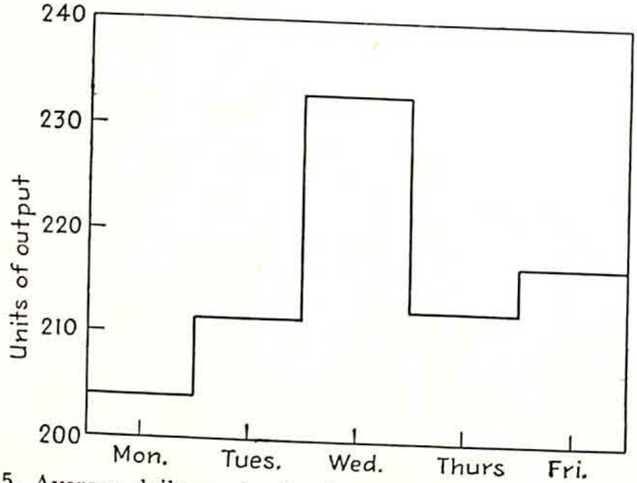

FIG. 1–5. Average daily production in a textile mill. (Data for 1950.)

Season of Year. Work curves are also affected by the season or the time of year. Industrial production is generally greater in the winter than in the summer. Vernon found that the maximum output of 104.4 per cent (of the yearly averages) in January dropped to a low of 94

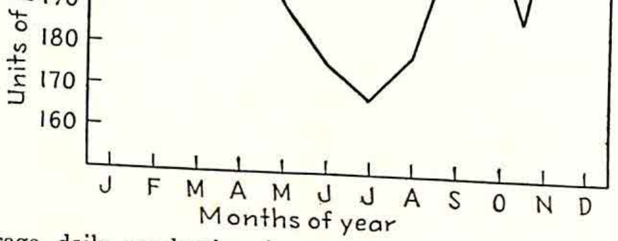

FIG. 1–6. Average daily production for each month in a textile mill. (Data for 1950.)

in August. However, the author has found July to be the lowest production month. The 1950 curve of production in a textile mill is shown in Fig. 1–6.

THE MEASUREMENT OF WORK

Work has been measured in a number of different ways, some of them dealing primarily with the work itself, some with the individual doing the work, and some with the method and speed with which it is performed. Each of these will be briefly described.

Physical Tests

Tests of physical factors in work usually isolate a simple activity and then measure some phase of it until fatigue reduces it to an inactive status. Obviously isolated muscles are also involved rather than those of the entire body.

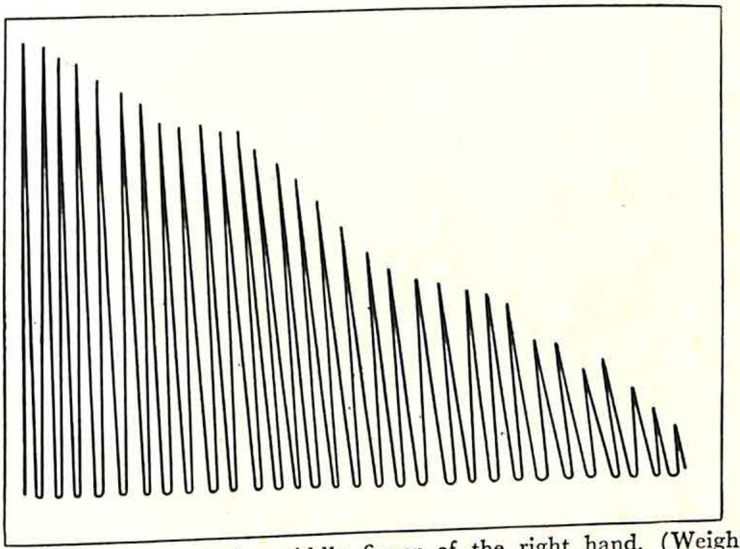

Fig. 1–7. Fatigue curve of the middle finger of the right hand. (Weight, 3 kg., interval, 2 seconds.)

Physical Endurance. The finger ergograph (more properly called an "ergometer") is a simple apparatus for measuring the repeated movements of a finger which is attached to a weight. The movement also activates a small lever which is in contact with a revolving kymograph. Thus a record (an ergogram) is made of the finger movements. As the weight is repeatedly lifted, the finger becomes fatigued, and the distance the weight is lifted is reduced. Figure 1–7 is an example of such a recording. Each vertical line indicates a finger contraction. The shorter lines indicate incomplete contractions. Finally it was impossible to contract the finger at all.

Ergograms vary considerably with different individuals but usually fall into three major types: (1) those which maintain a high level almost to the final point of exhaustion—when decrement starts the end comes quickly; (2) those which drop early but continue at a lower level for a considerable time before exhaustion; (3) those which decrease gradually with no level maintained for any considerable time. Such records are supposed to be indicative of the energy and endurance of the individuals on any type of work experience.

Ergographs are also used to measure the activity of other body parts—hand, arm, leg, foot. Viteles[4] reports that characteristic ergograms are constant for a given individual regardless of the part of the body measured. There is some evidence that the pattern of an individual's ergograms is also indicative of the pattern of his work on a job.

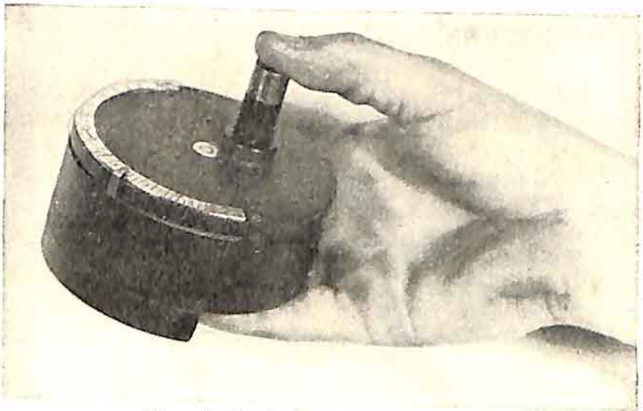

FIG. 1-8. A finger dynamometer.

Strength. Various forms of dynamometers are used to measure strength of hand grip, strength of arm and shoulder muscles, strength of fingers, etc. Figure 1-8 illustrates a dynamometer which the author devised to measure finger strength.[5] This apparatus indicates initial strength of certain muscles but is no indication of the rate of fatigue. It provides a measurement of initial output only.

There is some evidence that intellectually superior children are stronger, as indicated by dynamometer tests. Monahan and Hollingworth[6] found that when 45 pairs of eleven-year-old school children were matched in three respects (sex, age, and racial stock, but not intelligence) the more intelligent group (average IQ of 152) were stronger than the less intelligent group (average IQ, 100). There was an average difference of 1.6 kg., which was 3.33 times the P.E. of the difference. However, other studies have shown that when height and weight are kept constant, the relationship between intelligence and grip is negligible.

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[4] *Ibid.*, p. 445.

[5] A photo-finishing plant employed girls in the developing room. Among other duties it was necessary for them to depress a strong spring clip in which was inserted a film strip to dry. In hiring girls it was found necessary to measure this trait. The grip dynamometer did not measure this strength so it was necessary to devise a pinch dynamometer, or a *dactylometer*.

Speed. Speed of muscular action is measured by various forms of tapping tests and rate-of-manipulation tests. A simple tapping test is to depress a single key on a typewriter as many times as possible in 30 seconds. A more elaborate apparatus consists of a brass plate and a stylus connected through an electric circuit to an automatic counter. Each tap is thus recorded.

A typical rate-of-manipulation test consists of a board with 10 rows of small holes (10 holes to a row) in each end. There are 100 solid cylindrical pegs in the holes at one end. The test consists of moving these, one by one, to the holes at the other end.

Such speed and manipulation (dexterity) tests have had only doubtful value in practical situations. For example, Tiffin and Greenley[7] found that there was a partial correlation of but .22 between earnings and scores on a dexterity test when experience on the job was held constant. Candee and Blum[8] found a correlation of .26 between dexterity test scores and foremen's ratings of workmen in a watch factory.[8a]

Precision. A common test of precision, or the absence of muscle tremor, consists of a metal plate with holes in it of graduated diameter, a stylus, an automatic counter, and batteries, all connected in series. The testee is instructed to insert the stylus in the largest hole and then withdraw it without touching the sides. Each touch is recorded by the counter. The procedure is repeated for each hole from largest to smallest.

Steadiness tests have been used in studying the effects of various drugs and of tobacco. Hollingworth[9] found that three bottles of beer caused a loss of 68 per cent in steadiness. Using an ingenious piece of apparatus, called a "tromometer," Edwards[10] found that smoking (pipe, cigar, and cigarettes) without inhaling had a negligible effect on finger tremor, while inhaling greatly increased it. So-called "denicotinized" cigarettes had the same effect as standard brands. Breathing tobacco smoke in smoke-filled rooms had the same effect on finger tremor as direct smoking and inhaling. He found that smoking corn silk, even with inhaling, had no such effect.

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[6] Monahan, J. E., and Hollingworth, L. S., Neuromuscular Capacity of Children Who Test above 135 I.Q., *J. Educ. Psychol.*, 1927, 18, 88–96.

[7] Tiffin, J., and Greenley, R. J., Employee Selection Tests for Electrical Fixture Assemblers, *J. Appl. Psychol.*, 1938, 23, 240–263.

[8] Candee, B., and Blum, M., Report of a Study Done in a Watch Factory, *J. Appl. Psychol.*, 1937, 21, 572–582.

[8a] Statistical concepts are used throughout this book. A very brief explanation of the meaning of the more important ones is given in the appendix. The correlations mentioned here are low and indicate a relationship but little higher than chance.

Reaction Time. The interval of time between the occurrence of a stimulus, such as the sound of a bell, and the occurrence of a response to it is known as "reaction time." The procedure for measuring it is usually to connect both the stimulus and the response to a timing device, such as a chronoscope, so that the exact interval of time is recorded. This is but a small fraction of a second. Many experiments justify the following conclusions regarding reaction time:

1. It varies with the sense organ being stimulated.
2. It varies with the intensity of the stimulus.
3. It varies with the distance over which the neural impulses must pass.
4. It varies with the habituation of the response required.
5. It varies with the readiness of the subject for the occurrence of the stimulus.

A practical application of reaction-time measurement is in automobile driving. Here reaction time is the interval between the occurrence of a stimulus to stop and pressure on the brake pedal. Since the brake and the accelerator are both operated by the right foot, driving reaction time involves moving the right foot from the accelerator to the brake pedal. When a car is traveling at high speed, even a small fraction of a second is significant. (At 60 m.p.h., a car travels 88 ft. per sec.) A study of California drivers[11] showed that "good" drivers had a braking reaction time of 0.472 second while "poor" drivers had a braking reaction of 0.534 second. The significance of this difference is indicated by a critical ratio of 9. On the other hand Wechsler[12] found that, although taxicab drivers with very slow reaction time have many accidents, those with very fast reaction time also have many accidents. This is probably due to the fact that they are overconfident and take more risks.[13]

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[9] Hollingworth, H. L., The Influence of Alcohol, *J. Abnorm. Soc. Psychol.*, 1923, 18, 204–237.

[10] Edwards, A. S., The Finger Tromometer, *Amer. J. Psychol.*, 1946, 59, 273–283; The Effects of Smoking on Tremor, *J. Appl. Psychol.*, 1948, 32, 150–158.

[11] Reported in DeSilva, H. R., *Why We Have Automobile Accidents*, p. 66, John Wiley & Sons, Inc., New York, 1942.

[12] Wechsler, D., Tests for Taxicab Drivers, *J. Person. Res.*, 1926, 5, 24–30.

PHYSIOLOGICAL TESTS

Work is also measured by increased rate of heartbeat and by blood pressure, increased metabolic rate, the power of the blood to combine with and carry off carbon dioxide (CO_2), and increase of both white and red blood corpuscles. These effects, except heartbeat, are measured only by technical methods and so are practical only in research work.

Heartbeat. Heartbeat, or pulse rate, varies normally from 50 to 90 per minute, the average being about 72 for men and 76 for women. Any sort of activity will increase this rate, depending on the intensity or energy cost of the activity. Mental work of a nonexciting nature will increase the pulse only a few beats per minute, whereas playing football may cause a heartbeat of 180 per minute. Moss[14] and his colleagues found that moderate activity (riding a bicycle ergometer for 15 minutes) caused an increase in pulse rate of 113.5 per cent (see Fig. 1–10). Other studies also indicate that in normal healthy individuals, heartbeat is a fairly accurate indication of the amount of work performed.

Carlson[15] has found some evidence that vitality, especially in athletes, is indicated by the rate or quickness with which the heart returns from an accelerated rate (due to work) to a normal rate. The healthy and physically vital individual is the one whose heart rate returns to normal rapidly.

Blood Pressure. In 1732, Rev. Stephen Hales published a book in which he reported having studied blood pressure in the femoral artery of a horse. Since then science has learned a great deal about blood pressure and its significance. Blood pressure is determined by the energy of heart action (the systolic pressure caused by a contraction of the left ventricle, and the diastolic pressure caused by cardiac relaxation), the elasticity of the arteries, the resistance of the capillaries, and the volume of the blood. It is measured with a "sphygmomanometer," which consists of a rubber sleeve wrapped around the arm, into which air is pumped. As the air pressure increases, the blood circulation to the lower arm is shut off. The amount of air pressure necessary to shut off circulation is indicated by a mercury manometer. This pressure varies with individuals but is usually between 110 and 140 for systolic pressure and 50 and 65 for diastolic pressure. *Pulse pressure* is the difference between the systolic and the diastolic blood pressures.

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[13] Applications of the five physical tests just described will be discussed on occasion throughout subsequent chapters of this book. Here the purpose is merely to explain meanings so that subsequent applications can be understood more readily. These are the methods of measurements used in research and must be understood if that research, as reported later, is to be understood.

[14] Moss, F. A., *et al.*, Measurement of Fatigue by Physiological Methods. *J. Exp. Psychol.*, 1931, **41**, 423–438.

[15] Carlson, H. C., Fatigue Curve Test, *Res. Quart. Amer. Ass. Hlth. Educ.*, 1945, **16**, 169–175.

Work causes the systolic blood pressure to increase, sometimes as much as 60 per cent, and the diastolic pressure to decrease as much as 45 per cent. The pulse pressure obviously increases and is indicative of the expenditure of energy. (These changes are shown in Fig. 1–10.)

Metabolic Rate. The processes of chemical action on food within the body (digestion and absorption of food into the blood stream, transformation and storage of food by various body tissues, transformation of food into body tissue itself, oxidation of food in the process of body activity, etc.) are called *metabolism*. There is no very accurate way of measuring metabolism, but the method most commonly used is to measure the amount of oxygen consumption by the body and from that compute the Calories consumed, or the energy expended. (One-fifth of a liter of oxygen is necessary to produce one Calorie of energy.) A certain amount of metabolism is necessary to stay alive. This is called *basal metabolism* (BMR) and is expressed in terms of the Calories discharged in one hour for each square meter of body surface. This is about 38 (per sq. m.) for the average man and 36 for the average woman. Age, size, temperature, food, and activity all affect this rate. An overactive thyroid gland will cause the BMR to reach twice the normal amount.

Work has a very decided effect on metabolism. Heavy work may cause metabolism to increase ten times the BMR. A fairly large man may show a metabolic rate of as much as 760. This would mean an expenditure of 6080 Cal. for an 8-hour day, which would certainly cause exhaustion long before the end of the day. Ordinary day labor costs less than half this amount of energy.

The same amount of work per hour may cause an increased energy cost as a day's work progresses. Waller[16] studied the energy cost of work for each hour during the night shift for various departments in a London printing house. Some departments, such as proofreading, showed no difference from hour to hour. Other departments, such as typecasting, showed an increased metabolism for each consecutive hour of the 7.5-hour work period. The work performed for each hour was essentially the same. Waller's results are shown in Fig. 1–9. The abscissa shows the hours of the work period, and the ordinate, the cubic centimeters of CO_2 per second per square meter of body surface. If the area under the curve is divided into two equal parts by a vertical line at 10:30, or 5 hours after beginning work, it is obvious that the last 2½ hours requires an expenditure of the same amount of energy as the first 5 hours, yet only half as much work is performed. Whether this progressive energy cost, for the same amount of work throughout the day, is characteristic of other jobs in other localities is unknown. Certainly it is a general opinion that simple work often requires more energy than is justified by its simplicity. This is often taken as justification for a vacation. When a workman is expending more energy than that required by the nature of the work itself, careful study should be made to determine if the condition can be corrected. This is further discussed in Chap. 10.

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[16] Waller, A. D., The Physiological Cost of Work in Various Departments of a Printing House, *J. Physiol.*, 1920, 53.

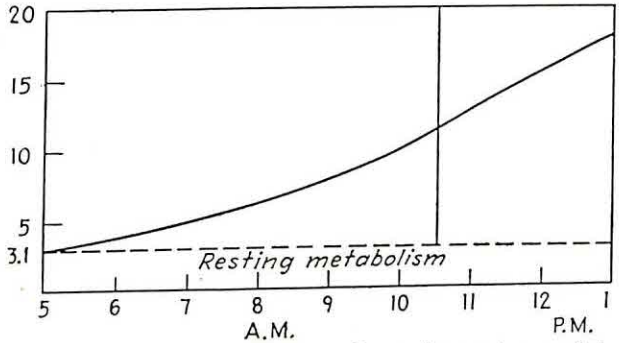

FIG. 1–9. Increasing energy cost of work uniform for entire workday (7.5 hours).

CO_2 Combining Power. One of the waste products produced by the oxidation of food (glucose) in releasing energy is carbon dioxide. This is carried to the lungs by fixed alkalines in the blood and then released. It has been found that 100 cc. of venous blood will carry 45 to 60 cc. of carbon dioxide gas, which exerts a pressure equal to about 5 per cent of an atmosphere. When it reaches the lungs, where the CO_2 pressure in the air is lower than that in the blood, the carbon dioxide is disassociated and breathed out by expiration.

In ordinary living, CO_2 is carried away by the blood almost as rapidly as it is formed. In extreme activity, however, the alkalies become less capable of combining with CO_2, and instead of carrying 50 cc. of CO_2 per 100 cc. of blood, there may be less than half this amount. This results in a concentration of CO_2 in the tissues. The process of oxidation (and consequent muscular action) is thereby sharply reduced.

Moss and his associates measured this reduction of CO_2 combining power of the blood and found wide individual differences but an overall average of 41 per cent (see Fig. 1–10). In one individual the reduction was from 56 to 24; in another, from 50 to 25, in another 49 to 29; and in another, 58 to 39.

Blood Count. Food products from the liver and oxygen from the lungs are carried to the muscles where oxidation releases energy for muscle action or work. Waste products from this locale of energy transformation are then carried away. The means of this intrabody transportation is the blood, a red-colored liquid of about 4.5 qt. However, the blood is more than a red liquid. It is made up of *plasma* (about 60 per cent) and *corpuscles* (40 per cent). The corpuscles, or cells, are of two major types—red (erythrocytes) and white (leucocytes and lymphocytes). The red blood cells contain a substance called "hemoglobin" (red in color) which combines with oxygen in the lungs and discharges it in the tissues where energy is being released. The white blood cells are fewer in number (one to each 500 red cells) and have an entirely different function—they destroy bacteria and thus protect the body from infection.

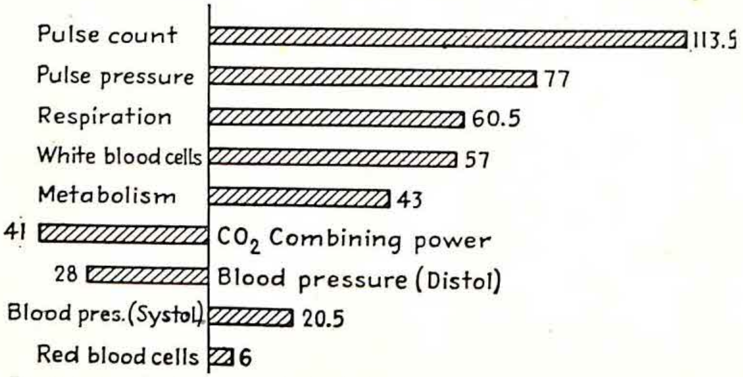

FIG. 1–10. Increase and decrease of physiological processes during work (in per cent).

Normally there are 5 million red corpuscles and 10,000 white corpuscles in each cubic millimeter of blood. Work brings about an increase of both kinds of blood cells, although the white ones increase more rapidly than the red ones. Moss found that 15 minutes on the bicycle ergometer caused the red blood cells to increase by 6 per cent and the white ones to increase 57 per cent. These results are shown in Fig. 1–10.

Like physical tests, physiological tests of work are not easily used outside the research laboratory. Pulse rate can be readily determined but blood pressure, metabolic rate, CO_2 combining power, and blood count can be determined only with the expert use of complicated apparatus. Again, the purpose of this chapter is to explain these measurements so that results of research reported in subsequent chapters can be understood.

AMOUNT AND QUALITY OF PRODUCTION

Regardless of how work is measured in scientific research, it is measured in practical situations by the amount and quality of production. A man who shovels 10 tons of coal does more work than one who shovels only 6 tons. A man who has 6 rejects per 100 machined forgings has done more work than one who has 10 rejects per hundred. The practical measure of work is the amount of acceptable product.

Amount of Product. The amount of output on a job is affected by a great many factors. Many of them are illustrated in the figures already discussed in this chapter; others are to be discussed in subsequent chapters. The work already done, the time of day, the day of the week, the month of the year, the vocational adjustment, morale, training, motivation, age and health of the workman, noise, ventilation, lighting, safety, temperature of the workroom, the methods of work, the kinds of work, the condition of the tools and machinery—all are factors which affect the amount of product a workman will turn out. To measure the effect of any one of these factors, it is necessary to keep records of the amount of production, both with and without the factor, and then to compare the records. (It is understood that other variables are to be kept constant.)

For example, Wyatt[17] wanted to know the relative value of three wage-payment plans—time rate, bonus, and piece rate. He kept careful records of the production of a group of men for a total period of 35 weeks during which they worked under all three payment plans. The results are shown in Fig. 1–11. Relative values in the workaday world are usually determined by the amount of production.

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[17] Wyatt, S., Incentives in Repetitive Work, *Industr. Hlth. Res. Bd. Rept.*, No. 69, London, 1934.

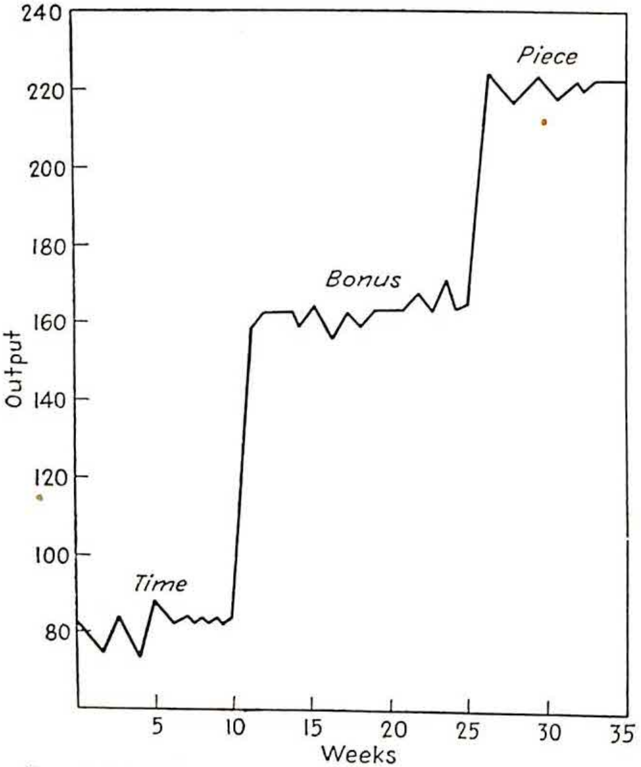

Fig. 1–11. Wage payment plans and rate of output.

Quality of Product. A few years ago a high-priced automobile on the American market advertised that in its manufacture there were:

36,000 operations with an accuracy of 0.002 in.
22,000 operations with an accuracy of 0.001 in.
800 operations with an accuracy of 0.0005 in.

The Norden bombsight contains a small ball bearing in which are balls accurate in roundness to within 0.00001 in., accurate in diameter to within 0.00002 in., and smooth to within 0.000001 in. These tolerances are more meaningful when it is realized that a human hair is 0.002 in. in diameter, or 200 times the largest tolerance allowed in the bombsight bearing.

Quality of product is almost in direct proportion to the amount of skill involved. Quality is relatively unimportant in common labor. It is more significant, yet a minor factor, in semiskilled work. It is of utmost importance in skilled work. To avoid the consequences of inferior products being put to use, most companies have inspection departments which detect and reject at origin any low quality work. Obviously, when the quality of a product is so low that it cannot be used, the company has a double loss—the loss of producing the useless product and the loss of the delayed production of acceptable product. Idle machines and idle men are better than operating machines and men when the product is of substandard quality.

Like quantity of production, quality of production is dependent on a number of factors but not always identical with those which affect quantity. For example, Muscio[18] reports a study of amount of typesetting and errors made as related to the time of day. Variations in quantity of work and quality of work did not occur concomitantly. These results are shown in Table 1–6. At 8 and 11 A.M. the quantity of work was about the same, but the quality of work was much lower at 11 than at 8. At 9 A.M. the quantity of work was the highest in the day, but the quality was not as high as at 2 P.M.

TABLE 1–6. QUANTITY AND QUALITY OF TYPESETTING THROUGHOUT A WORKDAY

Hour	Number of lines	Number of errors
8	21.0	17.0
9	26.0	10.0
10	23.0	18.3
11	21.5	28.0
Noon		
2	24.7	5.5
3	20.5	22.6
4	16.0	30.0

Quality of production is affected by many more factors than is quantity. Every factor mentioned in the following chapters of this book (and many additional ones) affects the accuracy of work. Often a product is affected directly by some factor which has no effect on the human element involved. Men are no less accurate, yet the product is inferior. For example, high humidity affects the lumber used in cabinetmaking and no degree of human accuracy will produce such high quality of output as is possible with low humidity. The determination and control

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[18] Muscio, B., *Lectures in Industrial Psychology*, p. 69, Routledge and Kegan Paul, Ltd., London, 1920.

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of factors which affect quality are very important in the control of efficiency.

MERIT RATING

Production work can usually be measured by one or more of the methods mentioned above. However, there are other characteristics of work which cannot be measured by any of the metrical procedures described above. Some of these factors are even more significant when evaluated in terms of worth to a company than the more accurately measured work factors. For example, honesty is more important in the work of a restaurant cashier than is his strength, or blood pressure, or basal metabolism. Likewise, ambition is a more important trait in the work of a young college professor than reaction time, or pulse rate, or CO_2 combining power.

Traits which are important and cannot be measured more accurately by metrical methods should be evaluated by *merit rating*. This is a procedure of judging the amount of a trait in the work of a certain individual by comparing him in that one respect with other individuals. In an industrial situation, a foreman may rate all the men in his department on the trait *cooperation*. He may rank them, or put them in groups—high, above average, average, below average, and low—or, if he is rating only one workman, he may simply label him as superior, average, or inferior.

Merit rating, then, is the determination by judgment of the amount or degree of any characteristic of work, or of a workman, for which a man receives at least a part of his wages. This judgment may be obtained in many different ways which cannot be explained here. The following rules or principles of merit rating are the result of studies of many different methods now in use in American business and industry:

1. Never merit rate a trait which can be measured more exactly in some other manner.

2. Describe the trait to be rated very accurately and in much detail. Give examples so that there will be no question of the exact meaning of the characteristic being rated.

3. Rate horizontally rather than vertically, *i.e.*, rate all men on one trait rather than one man on all traits. A foreman should rate all his men on cooperation, for example, and then a few days later rate them all on some other trait. This reduces the "halo" or carry-over effect which occurs when a workman is rated on several traits at the same time.

4. Have at least *three* independent ratings on every man by superiors who are well-acquainted with the work of each. In case of disagreements, hold a conference of the raters to determine which rating is most accurate.

5. Never rate a man whose work has not been known to the raters for at least 3 months.

6. Place a certain previously agreed percentage of workmen in each category or degree classification. For example, it may be decided to require each rater to place 10 per cent of his men in the superior group, 20 per cent in the above-average group, 40 per cent in the average group, 20 per cent in the below-average group, and 10 per cent in the inferior group. This forces all raters to make the same distribution and consequently they are comparable.

Merit rating is a crude way of determining values which would be determined even more crudely without it. It is the best method now known for evaluating factors which are nonmeasurable by metrical procedures. Further discussion of merit rating may be found in Chap. 6.

FATIGUE FROM WORK

When work is done by an inorganic machine there is an expenditure of energy (and consequent heat transformation) and a process of wearing out. The former process does not cause a work decrement, and the latter is so slow that a machine may operate continuously for months and even years. (The author has an electric clock which has been running continuously with no repair for over 17 years.) However, when work is performed by an organic machine there is an effect which makes continuity (without rest) impossible. This effect is called *fatigue*. There are two kinds of fatigue—physiological and psychological.[19] They may occur together or either may occur without the other.

Physiological Fatigue

Muscle Fatigue. The oxidation of blood sugar (glucose) in the process of muscular action produces a number of waste products—carbon dioxide, sarcolactic acid, potassium phosphate, etc. These are not carried away as rapidly as they are produced and so accumulate to form a blockage to further muscular action. (Figure 1–12 shows the rapid production of CO_2 during a short 8-minute period of muscular action.) This is one of the reasons why organic behavior is only about 22.6 per cent efficient.

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[19] It is doubtful if further research will justify this classification. Perhaps even now it would be better to call these two "aspects" rather than two "kinds" of fatigue. Distinctions between the physiological and the psychological are being less and less justified.

Muscle action also brings about a depletion in the reserve supply of carbohydrates, which is the fuel necessary for action. About 80 per cent of the food we eat consists of carbohydrates which are transformed by digestive processes into smaller molecules called glucose. This is then carried to the liver and stored in the form of glycogen. The blood normally carries only about 1 m. of glucose for each cubic centimeter of blood volume, or less than 0.1 per cent. As glucose is oxidized in the muscles, it is replenished by the liver (which converts its glycogen back to glucose). Continued activity depletes the reserve supply of glycogn in the liver, so that the blood can no longer be supplied with glucose. When the concentration drops to 0.07 per cent (hypoglycemia), there is a feeling of weakness and fatigue.

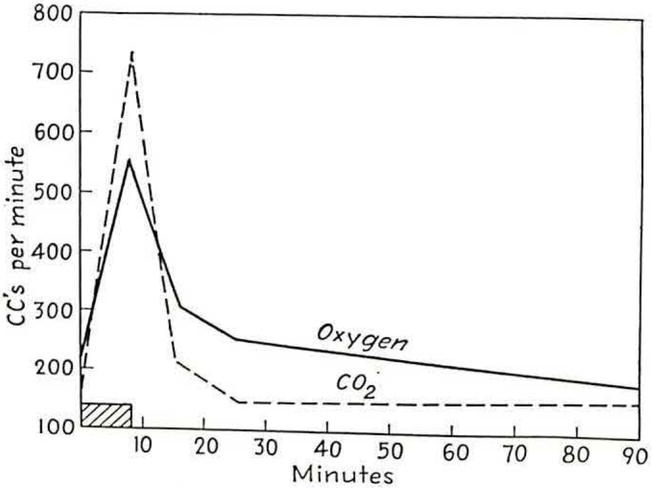

FIG. 1–12. Oxygen consumed and CO_2 excreted during and following 8 minutes of exercise.

A third physiological effect of activity is inadequate oxygen supply in the muscles. A man at rest uses about ⅓ liter (quart) of oxygen per minute. Activity may cause him to breathe in 15 liters per minute, but his lungs can absorb only about 4 liters per minute. This may be much less than the amount needed by the muscles. Oxygen has two functions in muscle activity—it is used in oxidizing glucose and in reconverting lactic acid into carbon dioxide and glycogen.[20] If there is not enough oxygen to serve both functions, muscle action is soon blocked.

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[20] When there is inadequate oxygen supply, lactic acid accumulates and must be oxidized, *after* the activity has ceased. Thus rapid and deep breathing continue in order to "pay the oxygen debt" which has been built up.

These three effects of muscle action—concentration of waste products, depletion of glucose, and inadequate oxygen supply—reduce that action and finally "block" it completely. Experiments indicate that the activity mechanism which is first blocked is the "end plate" or the connection between the neuron and the muscle fiber. In other words, the nerve end plate is the first part of the mechanism to tire, then the muscle fiber, and last to be fatigued is the nerve fiber.

It has been found that fatigue produced by the exercise of one part of the body affects other parts not exercised. For example Muscio exercised the second finger in an ergometer until it could no longer contract. He then tested other fingers of the same hand and found that they were fatigued more easily than normally. Ranke injected "extracts from the fatigued muscles of an exercised frog" into the circulatory system of an unexercised frog and produced the effects of fatigue. Fatigue is obviously a characteristic chemical composition of the blood and not a condition of prior muscle function.

TABLE 1-7. CHANGES IN NEURAL NUCLEI OF BIRDS DURING A DAY'S ACTIVITY

Bird	Time	Occipital cortex		Cerebellum		Spinal ganglia	
		Diameter of nuclei, mm.	Shrinkage, per cent	Diameter of nuclei, mm.	Shrinkage, per cent	Diameter of nuclei, mm.	Shrinkage, per cent
English sparrow	6:30 A.M.	6.69		8.31		10.69	
	6:30 P.M.	4.43	69.7	6.85	43.0	7.44	64.0
Pigeon	5:30 A.M.	10.59		12.74		13.88	
	7:30 P.M.	9.19	36.0	10.32	51.7	11.62	33.3
Swallow	5:00 A.M.	8.85		9.12		12.00	
	8:00 P.M.	6.84	55.4	6.32	64.5	9.82	45.2

Nervous Fatigue. In addition to the physiological effects of muscle action outlined above, there are also a number of marked changes which occur in nerve cells. Microscopic study of nerve cells after prolonged function shows that the *Nissl* substance is depleted. (This is believed to be some sort of nutrient material.) Rest restores it in about the same time required for muscle recovery.

There is greater resistance to the passage of neural impulses at the *synapse* following a period of continuous function. The *chronaxie* is increased and impulses to the muscles lag. This is probably due to fatigue products (CO_2, lactic acid, potassium phosphate) in the blood since it is definitely known that certain drugs (alcohol, for example) affect the synapses profoundly.

Then, there is some evidence that the nucleus of the nerve cell is affected by fatigue. It changes in shape and also in size. Hodge[21] found that there is a shrinkage in the diameter of neural nuclei in birds after a day's activity. His results are shown in Table 1–7. However, it is doubtful if these changes in the nervous system constitute fatigue in the sense that they cause a decrement of behavior. Some authorities insist that a nerve cell cannot be fatigued enough to cause it to cease functioning. One experiment blocked the sciatic nerve so that impulses could not reach the muscles. Stimulation at the rate of 15 per second was then maintained for 10 hours. When the block was eliminated, impulses went to the muscle with no evidence of fatigue. Further research, however, is necessary to solve adequately the problem of neural fatigue.

PSYCHOLOGICAL FATIGUE

Physiological states of fatigue may or may not be accompanied by feeling of fatigue, and feelings of fatigue may or may not be accompanied by physiological states of fatigue. A football player at the end of the third quarter may be in such a state of fatigue that his behavior is only half as strong and half as fast as normal, but he has no feeling of fatigue. He does not want to be taken out of the game. Physiologically he is fatigued, but psychologically he is not. The opposite is true when the alarm goes off in the morning. There is no physiological fatigue, but the feeling of fatigue is intense.

Psychological fatigue is variously called boredom, weariness, lassitude, and false fatigue. It is usually characterized (and often thereby distinguished from physiological fatigue) by the following conditions:

1. There is a *loss of interest* in the work being performed.
2. There is an *attitude of personal superiority* to the type of work.
3. There is *low morale* and definite dissatisfaction with the work.
4. There is no *characteristic decrement in the quantity and quality of work.*
5. There is *little or no desire or motivation to achieve goals* reached only by the work performed.

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[21] Hodge, C. F., A Microscopic Study of Changes Due to Functional Activity of the Nerve Cells, *J. Morphol.*, 7, 146.

In 1917, Thorndike[22] studied the relation of speed and accuracy in grading English compositions to the distastefulness of the work. He found but little relation. While the work became more and more distasteful, the speed and accuracy were not affected. His results are shown in Fig. 1–13.

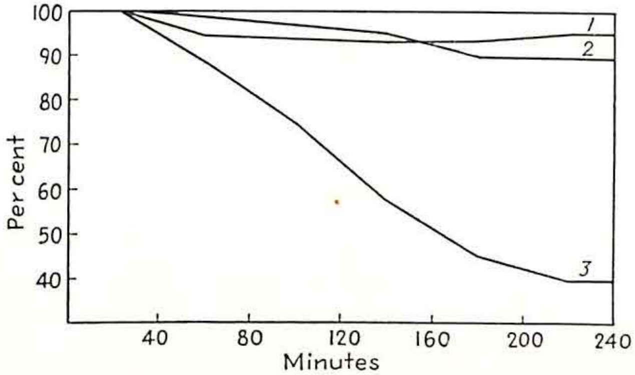

FIG. 1–13. Levels of (1) speed, (2) accuracy, and (3) satisfaction during 4 hours of mental work.

Poffenberger[23] studied the relation between feelings of weariness and accomplishment in mental work. He found that increasing weariness did not produce corresponding decrease in mental output. A sample of his results is shown in Fig. 1–14.

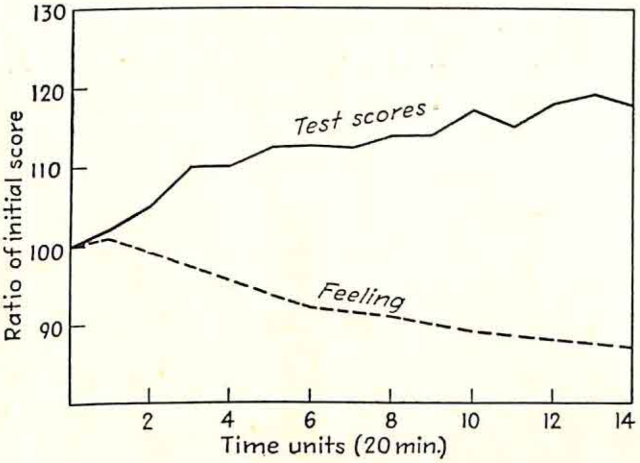

FIG. 1–14. Intelligence-test scores and feelings of well-being.

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[22] Thorndike, E. L., The Curve of Work and the Curve of Satisfyingness, *J. Appl. Psychol.*, 1917, 1, 265–267.

[23] Poffenberger, A. T., Effects of Continuous Work upon Output and Feelings, *J. Appl. Psychol.*, 1928, 12, 459–467.

While other studies substantiate these results, psychological fatigue is still a serious problem. Workmen will not stay on jobs which cause them to feel fatigued whether or not they are physiologically fatigued. Labor turnover is very high on such monotonous jobs. This problem is discussed further in Chap. 8.

Reduced Output

Regardless of technical aspects of fatigue, in practical industrial situations fatigue is "reduced productivity as a result of work." It is the decrease in the number of units which a workman turns out in a given unit of time. Fatigue is the decrement in work curves discussed earlier in this chapter. Figures 1 to 4 all indicate fatigue. Daily work curves in practical situations show the same decrement. A machinist does not do as much work or as good work at the end of the day as he does at the beginning. His output shows fatigue.

THE EFFICIENCY OF WORK

Efficiency may be defined in many ways. The dictionary says that the word has the same origin as the word "effect" and is that which is "characterized by energetic and useful activity." Some of the more typical concepts of efficiency are as follows:

1. Efficiency is sometimes understood to be the *antithesis of fatigue*. When fatigue is absent, efficiency is present. If work is nonfatiguing it is efficient. Any work which produces fatigue is correspondingly nonefficient.

2. Another understanding of efficiency is related to the *money cost of work*. When human labor is cheaper than machine labor, it is more efficient to use it. Slave labor is more efficient than machines, if it is cheaper. This is interpreting efficiency from the point of view of management.

3. An opposite point of view is that efficiency is the production of materials with the *least expenditure of human effort*. A hydraulic ram is an efficient pump because it requires no human effort. Automatically controlled machinery is efficient to the extent that human attention and effort are not required. Human efficiency is getting work done with the least human effort.

4. Efficiency is also understood to be the *ratio of the energy expended to the work accomplished*. A gas engine is said to be 15 per cent efficient —that is, 15 per cent of the calories of energy expended in the explosions

are directly used in performing the desired foot-pounds of work. The rest is wasted in friction, leakage, etc. Any elimination of wasted energy will increase efficiency.

There are many other concepts of efficiency, but it is obvious now that any interpretation of efficiency depends on *what* work is being done, *who* is doing it, and *why*. The efficiency of a man is one thing, of an institution is another, and of a machine is another. No single definition of efficiency will apply equally well to a baseball team, a diesel engine, and a steel-plant expediting system. Likewise, the purpose of work determines the meaning of efficiency. Efficiency on one job is determined by the speed of production, on another by the quality of production, on another by the cost of production, and on another by the ease of production. Efficiency is sometimes one thing and sometimes another, depending on what is being done, why it is being done and who (or what) is doing it.

For the most part this book concerns the efficiency of human beings in industrial situations, manufacturing durable and nondurable goods to be sold at a profit. With this in mind, the efficiency of workmen in manufacturing plants on production jobs can at least be discussed. Certainly the absence of fatigue is an important consideration. The economy of human effort must not be ignored. The enjoyment and satisfaction derived from the process are too important to escape attention. In the words of Poffenberger,[24] efficiency is "the production of maximum output of the highest quality in the shortest time, with the least expenditure of energy and with the maximum of satisfaction." Five objectives or goals would seem to be involved:

1. To increase the amount of production.
2. To improve the quality of the product.
3. To reduce the time required.
4. To reduce the effort of work required.
5. To increase the satisfaction of the worker.

SUMMARY

Work has been defined as the procedure of moving matter through space. It is accomplished by energy expenditure, which the human organism obtains from food. Distribution curves showing the amount of work accomplished in a given amount of time represent such characteristics as decrement, rest recovery, spurts, irregularity, diurnal and seasonal fluctuations, and individual differences.

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[24] Poffenberger, A. T., *Principles of Applied Psychology*, p. 364, Appleton-Century-Crofts, Inc., New York, 1942.

Work may be measured by physical tests, physiological tests, amount and quality of production, and merit rating. Motor tests are those of endurance, speed, strength precision, and reaction time. Physiological tests are of heart rate, blood pressure, metabolism, CO_2 combining power in the blood, and blood count.

Work always produces a degree of fatigue whether or not it is perceived by the worker. There are two kinds of fatigue—physiological and psychological. Physiological fatigue may be muscular and/or nervous. Muscle fatigue consists of those effects of muscular activity which reduce the ability of the muscles to perform further activity. It is largely an accumulation of waste products, a depletion of the fuel supply of glucose, and a depletion of oxygen in the muscles. Nervous fatigue is a state of increased synaptic resistance due probably to fatigue products in the blood stream. Psychological fatigue, or boredom, may or may not be accompanied by a state of physiological fatigue. Nevertheless psychological fatigue may be less easily endured by the workman than physiological fatigue. It is a more common cause of absenteeism and labor turnover than physiological fatigue. Curiously enough, it does not usually cause a reduction in the amount or quality of production.

Efficiency in work is defined as the maximum output of the best quality in the shortest time with the least effort and the greatest satisfaction. It is a goal which is never totally attained but toward which industrial psychology can make some contributions.

Subsequent Chapters. The following chapters in this book discuss the more significant factors which affect the efficiency of work as it is here understood. They review a representative sampling of the research concerning each of these conditions. No attempt is made to be original or to draw theoretical implications from the data. Accurate reporting has been the goal. Many factors which probably affect the worker's efficiency are not included because they have not been studied extensively enough to be discussed on a factual basis. For example, it may be that workmen are more efficient under a "private-enterprise" economic order than under a system of state ownership. However, this factor has not been studied scientifically (*i.e.,* with all variables controlled) and can be discussed only philosophically. While the research data reported in the following chapters are not always convincing, and sometimes are even contradictory, they have been gathered with care and represent the first steps toward a science of human engineering.

RECOMMENDED READINGS

BARTLEY, S. H., and CHUTE, E.: *Fatigue and Impairment in Man,* McGraw-Hill Book Company, Inc., New York, 1947.

BILLS, A. G.: *The Psychology of Efficiency,* Harper & Brothers, New York, 1943.

BURTT, H. E.: *Psychology and Industrial Efficiency,* Appleton-Century-Crofts, Inc., New York, 1929.

GHISELLI, E. E., and BROWN, C. W.: *Personnel and Industrial Psychology,* McGraw-Hill Book Company, Inc., New York, 1948.

GRAY, J. S.: *Psychology in Human Affairs,* Chap. 15, McGraw-Hill Book Company, Inc., New York, 1946.

HARRELL, T. H.: *Industrial Psychology,* Rinehart & Company, Inc., New York, 1949.

MAIER, N. R. F.: *Psychology in Industry,* Chaps. 14–15, Houghton Mifflin Company, Boston, 1946.

MAYOR, E.: *The Human Problems of an Industrial Civilization,* Chaps. 1–4, The Macmillan Company, New York, 1933.

MOORE, H.: *Psychology for Business and Industry,* Chap. 13, McGraw-Hill Book Company, Inc., New York, 1942.

POFFENBERGER, A. T.: *Principles of Applied Psychology,* Appleton-Century-Crofts, Inc., New York, 1942.

RYAN, T. A.: *Work and Effort,* The Ronald Press Company, New York, 1947.

TIFFIN, J.: *Industrial Psychology* (2d ed.), Chap. 12, Prentice-Hall Inc., New York, 1947.

VERNON, H. M.: *Industrial Fatigue and Efficiency,* E. P. Dutton & Co., Inc., New York, 1921.

VITELES, M. S.: *Industrial Psychology,* Chaps. 21–22, W. W. Norton & Company, New York, 1932.

Chapter 2

WORK ANALYSIS

- An Overview
  - Readings
    - Books
    - Government Pamphlets
    - Census Reports
    - Other Sources
  - Pictures
  - Field Trips
  - Temporary Occupation
- Job Analysis
  - Identification Data
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  - Sources of Workers
  - Performance Requirements
    - Responsibility
    - Job Knowledge
    - Mental Application
    - Dexterity and Accuracy
  - Comments
  - Physical Demands
  - Characteristics Required of a Worker
- Summary

How well are men satisfied with the jobs they perform day after day? Bell[1] reports that 98 per cent of a group of young men and women who worked in canning factories and textile mills hated their jobs. Happock[2] queried a group of 309 adults during the depression and found that 30 per cent positively disliked their work, and another 24 per cent would have liked to change both jobs and occupations. Starch[3] asked a cross section of Americans what three things they would do differently if they could live life over again. The item mentioned most frequently was: Choose a different occupation. Almost one-third (32.7 per cent) of those queried placed this first. A review of various studies of job satisfaction by Happock and Spiegler[4] indicates that no less than one-third of American wage earners are dissatisfied with their occupations. Fisher and Hanna[5] suggest that vocational dissatisfaction is the greatest cause of industrial unrest today. Men who are not satisfied with their work are more sensitive to irritations from other sources. They soon become irritable personalities and "troublemakers."

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[1] Bell, H. M., *Youth Tell Their Story,* American Youth Council, Washington, D.C., 1937.

[2] Happock, R., *Job Satisfaction,* Harper & Brothers, New York, 1935.

[3] Starch, D., as reported in the *Syracuse Post-Standard,* Nov. 8, 1936.

[4] Happock, R., and Spiegler, S., Job Satisfaction, *Occupations,* 1938, **16**. 636–639.

A second question even more pertinent but more difficult to answer is: How well are men fitted for the jobs they perform day after day? A man may be dissatisfied with his job because he is not well-fitted to perform it, or he may be satisfied with it and yet better qualified for some other job. Certainly men are not all equally qualified for the jobs they perform. While some could do nothing else better, others could find nothing else for which they are less suited. The extent to which workmen are or are not performing the work for which they are best qualified has not been carefully studied by many American industries. So long as there is a plentiful supply of labor, top management will not approve of the expenditure of funds to discover ways and means of using manpower more efficiently. It is just as cheap to hire a great musician to dig a ditch as it is to hire a ditch digger *if both are paid per foot for the work done*. However, the workman who is not fitted for his job will soon quit and it will be necessary to hire another. Labor turnover has been variously estimated to cost American industry from ½ to 1½ billion dollars per year. Nevertheless, tabulated data showing how well workmen fit the jobs they perform still are hard to find.

It is obvious now that there are two factors involved in occupational adjustment—psychological adjustment, or being satisfied, and ability adjustment, or performing work for which one is best fitted by both nature and training. Such adjustment may be obtained in two ways—by trial and error and by scientific methods. The trial-and-error procedure is long, costly, and of doubtful consequences. Many occupations require such long training periods that an error may cost thousands of dollars and years of time. Hartson[6] found in a study of Oberlin men graduates from 1914 to 1922 that in 1926 only 75 per cent were in occupations of their original choice. The other 25 per cent were in occupations of second and third choice. Even college graduates use the trial-and-error method of occupational adjustment.

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[5] Fisher, V. E., and Hanna, J. V. *The Dissatisfied Worker*, The Macmillan Company, New York, 1931.

[6] Hartson, L. D., Vocational Stability of Oberlin Alumni, *Person. J.* 1928, 7, 176–185.

The alternative is to use scientific procedures of occupational analysis followed by human-ability analysis. Occupational choice can be based on factual information about occupations and about the individual concerned. There are ways of collecting information about both occupations and individuals which are technical and require specialized training for use. This and the following chapter review some of these methods briefly.

Occupational analysis is a procedure of obtaining information about the various jobs that may be found in an occupation. It is a method of collecting facts about what men do in the process of making a living. The results of such an analysis afford information about what men do in an occupation and what qualifications are required to do it. Perhaps some definitions are required at this point.

A *task* is an act or a series of acts performed to accomplish a specific purpose. It is a unit of work. A series of tasks requiring the entire efforts of a single workman is a *position*. A position consists of whatever tasks a workman may perform. There are as many positions as there are workmen. When the tasks performed in a number of positions are essentially the same, there is a *job*. The operation of a simple punch press is a job. There may be 200 machines and 200 operators (therefore 200 positions) but just one job. A group of related jobs constitutes an *occupation*.

Writing this chapter is one of many *tasks* which the author performs in his *position*. There are a number of other positions, however, which would be included in a *job* description of "Instructor in Psychology." This is one of the many jobs which make up the *occupation* of teaching.

It is obvious now that the analysis of an occupation requires a primary acquaintance with the jobs involved and with the various tasks performed on those jobs.

AN OVERVIEW

The first step in occupational analysis is an overview of the occupation. What tasks are performed? What training is required? Where are the positions located? What are the average and the range of remuneration? What is the trend of employment, What is the "social status" of the occupation? What are the usual working conditions? What hazards are involved? What is the regularity of employment? All these and other questions should be answered about a job field before a man decides to enter it. Most occupations have jobs requiring so many levels of ability that the first problem of the job hunter is not so much to find a job that fits him as it is to find a job field or occupation that he likes. In other words, the first step is one of interest rather than ability. For example, farming is an occupation in which there are jobs ranging from common labor to high levels of managerial function. A man with most any level of ability can be appropriately placed in that occupation. The question is does he *want* to be a farmer.

An overview of an occupation can be obtained in many ways—reading, moving pictures, conversation, field trips, temporary employment, etc. The important factor is not the method of obtaining the overview but the degree to which it is experiential. An occupational overview is not an academic acquisition. It is an acquaintance which is gained only by experience. It is not a matter of facts; it is a comprehension of the significance of facts. The purpose of an occupational overview is to discover whether or not an individual wants to live a large portion of the rest of his life in that environment. It is to assist the individual in his evaluation of a way of life.

The techniques for obtaining an occupational overview described in the following pages will vary with a number of conditions—the age of the person concerned, the materials and opportunities available, the location of the analysis (whether in an employment office, in a school, or in a vocational-counseling center), the length of time available, the funds available, and the thoroughness desired. Seldom will a single overview make use of all these techniques to any great extent. They are briefly outlined here for purposes of reference.

READINGS

Perhaps the first step in making a serious occupational study is to go to the library and read about the occupation. Books, government pamphlets, and special reports of the many vocational-guidance organizations are available in most libraries.

Books. There are so many books describing occupations that few will be found in all libraries. Some briefly discuss a large number of occupations,[7] and others deal with a single occupation in more detail.[8] Any local librarian will make available for the asking the resources of her library on any occupation. Some books will be too technical and will go beyond the needs of a mere overview. The reader will, of course, have to be selective.

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[7] Such as Williamson, E. G., *Students and Occupations,* Henry Holt and Company, Inc., New York, 1937.

[8] Such as Price, M., *The A B C of Architecture,* E. P. Dutton & Co., Inc., New York, 1927.

Government Pamphlets. Our government has published much excellent material on a wide range of occupations. This is distributed through the Government Printing Office and various other government agencies, especially the Occupational Information and Guidance Service of the U.S. Office of Education, Federal Security Agency, and the Occupational Outlook Service of the Bureau of Labor Statistics in the Department of Labor. A number of excellent bibliographies are published by the Office of Education and by the Department of Labor. Another publication of the latter is the *Monthly Labor Review*. The government also publishes job descriptions for a large number of occupational fields, covering such diverse subjects as lumber and lumber products, automobile manufacturing, bakery products, cotton textile, machine shops, knit goods, hotels and restaurants. These are available in most libraries and can also be obtained by anyone from the Superintendent of Documents, Government Printing Office, Washington 25, D.C., at a slight cost. A good bulletin with which to begin an occupational overview is *Guide to Occupational Choice and Training,* by W. J. Greenleaf, published by the Government Printing Office. It discusses some of the sources of occupational information and then gives a very carefully selected and annotated bibliography.

Census Reports. It is vitally important to know whether an occupation is on the increase or decrease, how large it is in terms of the number employed, where the positions are located, etc. This information is obtainable from the decennial census reports. For the average reader, however, these are difficult to digest. The Department of Commerce publishes an abstract of each census which contains the principal tables and graphs of the 30 or more volumes of statistical data. This summary volume is found in most libraries. Other census digests are published by various private sources. A book called *Occupational Trends in the United States* by Anderson and Davidson is published by Stanford University Press. It shows how changing conditions from 1890 to 1940 have influenced the number of gainfully employed in a large number of occupations. Other abstracts of census data are found in *The World Almanac* by the *New York World-Telegram, The Information Please Almanac* by Doubleday & Company, Inc., and *The Yearbook* by the *Denver Post.*

Other Sources. Excellent reading material on occupations can be obtained from a number of other sources. Books, pamphlets, monographs, and leaflets are published by the institutions and organizations listed below. (Special mention should be made of the magazine *Occupations* published by the National Vocational Guidance Association.)

Institute for Research, 573 S. Dearborn Ave., Chicago.
Commonwealth Book Co., Inc., 80 E. Jackson Blvd., Chicago.
Science Research Associates, 57 W. Grand Ave., Chicago.
Occupational Index, Inc., New York University, Washington Sq., New York.
Morgan-Dillman Co., 5154 Clark St., Chicago.
Delman Publishing Co., 6 Park St., Boston.
National Vocational Guidance Association, 525 W. 120th St., New York.

PICTURES

Better even than reading about something is seeing pictures of it, or better yet, supplementing the reading with pictures. An illustrated explanation is not only more easily understood but it is also more meaningful. A carefully written description of the work of a steam-hammer operator in a forge plant gives the reader a very inadequate appreciation of the actual work done and the conditions under which it is performed. Photographs and moving pictures, especially technicolor sound movies, make the description more vivid. The noise and hissing steam and flying sparks and sun-bright furnaces are heard and seen in the sound film. (Of course the heat and vibration and pungent odors are missing even in technicolor pictures.) Vicarious experience is more vivid when pictures are used with either written or verbal forms of communication.

Pictures which deal with occupations in function are of four kinds: photographs, usually found in reading matter; filmstrips, merely photographs projected on the screen; silent moving pictures, showing operations but otherwise no better than photographs; sound moving pictures, in black and white but with operation noises; and technicolor moving pictures with sound. All of these are available at most moving picture film libraries.

Films which are especially useful in widening the experience of the young person in the workaday world are produced and distributed by Vocational Guidance Films, Inc., Des Moines, Iowa. They may be bought or rented. The same company also sells filmstrips which show still pictures of a large variety of occupations.

The Erpi Classroom Films distributed by the University of Chicago deal with a wide variety of occupations. Typical film titles are *The Wheat Farmer, The Plastic Arts, The New England Fisherman, The*

Modern Lithographer, The Machine Maker, and Furniture Craftsmen. One film, *Choosing Your Vocation,* shows the advantages of scientific vocational choice over the more usual trial-and-error method.

Excellent vocational films are produced by many of our large industries. They are often free for school use (because of the advertising involved), and otherwise rent for only a nominal fee. The following list of such films is by no means complete.

Ford Motor Co.	Science Rules the Rouge
National Broadcasting Co.	Television
General Motors	Modes and Motors
United Air Lines	Coast to Coast by Plane

In almost every state there are film-renting libraries where vocational films may be secured. Usually there is one at the state university. The Federal government has many films which may be borrowed for the cost of transportation charges. These are listed in a *Directory of U.S. Government Films,* which is distributed by the U.S. Office of Education. The YMCA—at 147 Madison Ave., New York; 19 S. LaSalle Street, Chicago; and 351 Turk St., San Francisco—has large libraries of rental films on various occupations. The American Film Center, 45 Rockefeller Plaza, New York, will furnish information concerning films available on almost any subject.

It cannot be overemphasized that moving pictures, especially those in technicolor and with sound, are valuable supplements to reading matter about occupations. Something of the "feel" of an occupation which is absent from the printed page can be gotten from moving pictures.

Field Trips

The author recently spent a year as a consultant for a large industry which employed young graduate engineers. These boys were given 9 months' training before they were assigned to research, production, or sales positions. Great care was exercised to select men who would make good. At company expense, each applicant was entertained at the home plant where he was carefully interviewed and given a battery of psychological tests. However, the first step after a man arrived was to take him on a tour of the plant. This trip was intended to enable him to decide whether to enter a highly specialized field which had but little transfer value in other types of engineering. It helped to round out an overview which was already in the process of formation.

A good way to avoid rapid labor turnover in any employment situation is to take prospective employees on a tour of the job locale. A man is less likely to take a job in incompatible surroundings if he knows what it is like before he goes to work. A plant tour is relatively inexpensive compared to the cost of hiring and training a man who soon quits because he does not like the occupation.

The number and expense of field trips will be determined by the situation. Students of secondary school age should visit all sorts of occupations. Their interests are unformed and they have plenty of time for vocational exploration. Older students usually have limited their interested fields to a related group of occupations. Field trips for them should be adjusted accordingly. When a single occupation is being studied, field trips can be limited to various sites of that occupation.

A field trip is more meaningful if careful preparation is made for it. It is possible to walk through a plant and see little of vocational value. On the other hand, a field trip may afford meaningful experience second only to actual work in the occupation. It should be slow, with plenty of time for talking with workmen, if that is allowed. A vocational field trip is not a sight-seeing tour for entertainment. It is a method of developing the overview of an occupation.

Five rules may be observed for field trips when the object is an occupational overview.

1. Arrange for the trip with officials of the concern several days in advance. Inform them of the purpose of your trip. Be on hand promptly at the location designated.
2. Stay with your guide and never precede him. Direct all your questions to him. Talk to workmen only with his permission. (It is appropriate to ask for this.)
3. Touch nothing without permission. Handle objects only when invited to do so.
4. Do not try to understand technical operations. That is not the purpose of your trip. You are there for an overview of an occupation and not for an analysis of a position.
5. Observe the general nature of the work done and the conditions under which it occurs. Try to decide if you would care to earn your livelihood in the same occupation.

TEMPORARY OCCUPATION

The best way to round out an occupational overview is to secure a temporary job in the occupation and get some primary experience. An ordinary common-labor job will afford a sample of what life is like in that occupation. Men in almost every occupation who have reached the top started at the bottom in some menial capacity. Often they worked at the bottom in several occupations before they found one that they liked. One never quite appreciates what an occupation is like until he has worked in it.

High school and college students often spend their summers working in different occupations. A former student of the author spent successive summers on a farm, in a steel plant, on a railroad, and in a law office. By his junior year, his interests were definitely localized in personnel management. When he graduated he chose the railroad as the locale of his occupation. In a few years, after successive promotions, he was in a position commensurate with his qualifications. His summers of varied occupational experience enabled him to round out overviews of a number of different occupations. While his work was mostly on the common-labor level, he was able to experience personnel management from "the other side of the fence." His vocational choice was the result of this experience.

Industries sometimes use temporary employment as an exploratory step in effecting more adequate job adjustment. Many job shifts occurred during the war, often to unrelated occupations. Some became permanent and others did not.

Harry C was a poorly adjusted and relatively unsuccessful newspaper reporter. On visiting a war plant for a news story, he was spotted by one of the officials as a potential personnel man. Harry was induced to try out a temporary job in the personnel department, with the understanding that he could return to his newspaper work any time within the first year. He soon became interested in personnel work, learned his new job the hard way, and in few years was personnel director. On the other hand, Mr. G's experience was just the opposite. He was a dissatisfied high school teacher who wanted to be in war work. He resigned and took a position in the training department of a war industry at a salary almost double that which he received as a teacher. Three months were enough. In spite of still greater salary inducements, he resigned and went back to high school teaching. Temporary employment illustrates the truth of the old saying that "the proof of the pudding is in the eating."

JOB ANALYSIS

After the overview of an occupation has been made and interest in the occupation is apparent, the next step is a study of the various jobs involved. The procedure of job study is called "job analysis." This is a comparatively new technique in American industry but has grown rapidly. Early in the recent depression decade, the Secretary of Labor (Frances Perkins) appointed a technical board to supervise the research of the newly created U.S. Employment Service. Thousands of jobs were carefully analyzed, and a series of publications resulted. Among the most useful were the *Dictionary of Occupational Titles* (known as the DOT) and a series of volumes of job descriptions for specific industries. Soon a technique of job analysis developed which is described in *Training and Reference Manual for Job Analysis,* published by the War Manpower Commission. This manual is briefly reviewed in the following pages.

Job analysis is the procedure of discovering pertinent information concerning a specific job. It culminates in a description of tasks, procedures, knowledge, skills, abilities, and responsibilities involved in the performance of a job. There are three fundamental steps—accurate identification of the job, complete and accurate description of the job, and identification of essential worker characteristics.

The first step can usually be accomplished by referring to the *Dictionary of Occupational Titles* and identifying the job with the proper code number. The second and third steps require various degrees and kinds of research to discover *what* the worker does, *why* he does it, *how* he does it, and what *skills* are essential. To get this information the government developed a "job analysis schedule," or a guide for job analysis. There are seven steps or parts in this schedule which should be followed in the analysis of each job. A bird's-eye view of these steps is shown in Table 2–1.

IDENTIFICATION DATA

Jobs are commonly identified in the local plant or business by some title or name. This title may be peculiar, inappropriate, and confusing, but it must not be changed. The job name is whatever it is called in the establishment in which it is found. Often a job is known by several titles. All alternate titles should be recorded *verbatim*. Then, by the use of the DOT, the official title and identifying code number can be found. This is usually recorded on a job description, or write-up, in parenthesis. The industry in which the job is located, the local plant name, and the department or division should all be recorded with the identifying data. The number of positions, or workers employed, should also be included.

TABLE 2-1. JOB ANALYSIS AND APPLICATIONS

Identification Data	
Includes: 1. Title by which the job is known 2. Industry and subdivision in which it occurs 3. Number employed, sex employed and sex preferred 4. *Dictionary of Occupational Titles* title and code 5. Schedule and study number	Major applications: 1. Classification of applicants and job ordered 2. Data for industrial code and classification 3. Sex employment information 4. Cross-reference and filing information
Work Performed	
Includes: *Job statement*—a brief survey of the job, indentifying it and orienting the reader in relation to the *Job elements* which are a series of concise statements describing each task in terms of *What* work is done *How* it is done *Why* it is done, together with additional explanatory information necessary to clarify, the *what, how and why,* to preserve narrative transition, and to relate the work performed to other parts of the schedule	Major applications: 1. Basic data for job descriptions, interviewing aids, definitions for the *Dictionary* 2. Basic data for job specifications and employee orders 3. Job dilution or job reengineering projects of labor utilization studies 4. Identifies job for the selection of aptitude-tests batteries 5. Oral trade tests 6. Supplies information for determining job relationships on the basis of work done, machines and tools used, and materials used 7. *Dictionary* Part IV classifications
Performance Requirements	
Includes: *Responsibility*—which goes with the job for the supervision of others, for the prevention of damage to equipment, materials or processes, for the safety of self and others, and for cooperation with others *Job Knowledge*—of equipment, materials or processes, and procedures and techniques *Mental application*—the exercise of initiative, ability to make independent judgments, attentiveness and alertness *Dexterity and accuracy*—the manipulative deftness, coordination, and precision required	Major applications: 1. Significant job factors section of Job Descriptions 2. Skill studies 3. Development of job training programs 4. *Dictionary* Part II and Part IV classifications 5. Aptitude and trade tests selection 6. Details to aid in evaluating Worker Characteristics 7. Preparation of job specifications

TABLE 2-1. (*Continued.*)

Physical Demands	
Includes:	Major applications:
1. Physical activities such as walking, seeing, hearing, lifting, etc. 2. Working conditions such as lighting, heat, odors, etc. 3. Hazards such as likelihood of injuries or occurrence of occupational diseases	1. Selection and placement of workers on the basis of physical capacities and limitations, especially the placement of women and rehabilitation of disabled
Worker Characteristics	
Includes:	Major applications:
1. Rating of 47 basic characteristics, such as strengths, dexterities, memories, estimations, and perception abilities required for job performance	1. Basis for the development of job families of apparently unrelated jobs 2. Used in the selection of tests for experimental aptitude batteries
Source of Workers	
Includes:	Major applications:
1. Experience and training information 2. Relation to other jobs	1. *Dictionary* Part IV 2. Job specifications 3. Upgrading studies 4. Training briefs 5. Organizational studies
Comments	
Includes:	Major applications:
1. Description and listing of equipment, materials, and supplies. Definition of terminology. General comments which "footnote" all parts of the schedule.	1. Clarification of the schedule itself and of the circumstances under which the schedule was written 2. Definitions of terms and equipment descriptions often provide clues for the development of trade tests

Most companies use job analysis blanks on which there are spaces for filling in these data. The following blank was used by one company in recording identification data.

1. Local job title________________
2. Alternate titles________________
3. DOT title________________
4. DOT code number________________
5. Name of industry, plant and department________________

6 Number of employees on this job________________

THE WORK PERFORMED

This step contains the gist of a job analysis. It tells *what* the worker does, *how* he does it, and *why* he does it. It requires careful observing of the work done and talking with workers and supervisors and may even include performing the job. Any method of getting an accurate, clear, and complete understanding of the work performed is justified.

A description of the work performed must be simple, exact, logical, and detailed enough to give a naive reader an accurate mental picture of the work done. Usually a good job description will state the gist of the work performed in a single introductory sentence and then follow with a detailed description of each task in the order in which it is performed. The description should use short sentences and conform to four rules for writing:

1. The style should be terse and direct.
2. It should be in the present tense.
3. Each sentence should begin with a functional verb.
4. Every word should impart necessary information.

When possible, it is helpful to include the percentage of time the worker devotes to each task. If this is less than 5 per cent the notation may be "rarely."

The following description was written by one of the author's students after analyzing a job called "charging-machine operator." The analysis may be inaccurate in some details but it illustrates the desired style of a job description of "work performed."

Charges seven 140-ton open-hearth furnaces by means of an electrically controlled charging machine.

1. Operates electric controls that move the charging machine sidewise, up and down the open-hearth floor on double tracks 20 ft. apart running parallel to the face of the furnaces.

2. Operates electric controls that move the trolley (upper part of the charging machine) forward and backward on double tracks, which are an integral part of the carriage and at right angles to the floor tracks, transporting charging boxes in and out of furnaces.

3. Operates electric controls that rotate and position plunger arm on trolley. Picks up boxes with this control from small flatcars on narrow-gauge track immediately in front of furnaces, moves these into furnace and dumps contents (scrap, limestone and pig iron), returns empty box to flatcar and repeats operation.

4. Operates electric controls to position hot metal spout in front of furnace door. (about four times each 8-hour shift.)

SOURCES OF WORKERS

This section of the job analysis schedule is designated to indicate where workers can be recruited for the job analyzed and, conversely, to point out the experience and training that a worker who is seeking the job must have. The two broad sources of worker skills are experience on the job and training for the job.

Some jobs require no special training but preliminary *experience.* To become a journeyman diesinker it is necessary to spend from 3 to 5 years as an apprentice. Other jobs require no special experience but preliminary *training.* In most states a lawyer must graduate from an approved law school and pass the state bar examination. No experience is necessary. Still other jobs require *both* special experience and special training. A psychiatrist must graduate from an approved medical college, pass the state medical examination, and have at least one year of experience as an interne in a psychiatric hospital. Some jobs require *neither* experience nor training. Most common labor jobs have no such requirements.

It is important for the job analyst to record the exact amount of training and experience required for a job and how these are to be acquired. Often there are established lines of promotion by which all worker recruitment takes place—preliminary experience on other related jobs is then the only source of workers. But whatever the characteristics of the sources of workers for a job, they should be exactly and clearly described on the job analysis.

PERFORMANCE REQUIREMENTS

The first three steps in the job analysis schedule can be obtained by diligent study and observation of the job itself. Performance requirements, however, deal more with intangible factors which can be learned only by a more subjective analysis and evaluation of work performed. It is necessary in this step to determine the level of difficulty of the job tasks and of the job as a whole. Four factors have been found adequate to establish the difficulty level of any job—whether manual, craft, professional, or clerical—and determine its importance. These are responsibility, job knowledge, mental application, and dexterity (including accuracy).

Responsibility. The amount of responsibility determines in part the importance and difficulty of a job. Responsibility exists where errors have costly consequences. The amount of loss from negligence determines the degree of responsibility.

Four areas cover most worker responsibility:

1. Responsibility for material or product.
2. Responsibility for equipment or process.
3. Responsibility for the work of others.
4. Responsibility for the safety of others.

The degree of responsibility in these areas can be determined by investigating the probable cost of negligence in money value, in number of people supervised, and in seriousness of potential injuries. If the worker is closely supervised in work with costly equipment, for example, the supervisor assumes and should have credit for much of the responsibility.

Job Knowledge. This includes *all* the knowledge required by the worker on the job regardless of how or where obtained. The job analyst must review each task and consider exactly what the worker must know in order to perform the task. It is not enough to say that a duplicator operator must know how to operate a Keller machine. Rather, the analyst must specify exactly what he should know in the various unit tasks involved in operating a die-cutting duplicator. Specifically, he must know how to use a micrometer, a vernier caliper, a bevel protractor. He must know how to read die drawings. He must know how to use, and when to use, various cutters and what speeds are appropriate for each. He must know how to set up a Keller machine so that it will duplicate dies with very small tolerances. In short, a duplicator operator in a die shop must know a great many things which the job analyst should describe exactly and in sufficient detail to give the reader an accurate mental picture of the job in operation.

The knowledge necessary to perform a complicated job may be classified under appropriate headings. For example, the knowledge necessary for die cutting and similar jobs may be written up under the following headings:

1. Knowledge of machines and equipment used.
2. Knowledge of materials used.
3. Knowledge of working procedures and techniques.
4. Knowledge of product flow or process as related to the job.
5. Knowledge of dimensional calculations.

The analyst must always consider what a new man being hired must know in order to perform the operations of a given job at standard speed and with standard accuracy.

Mental Application. This concerns the necessity of making judgments. If the job is highly repetitive and closely supervised, the worker has to do but little thinking. The amount of mental application on a job is indicated by the complexity, scope, and variety of tasks and skills involved; by the importance of decisions made; by the extent of planning necessary; and by the frequency and difficulty of problems occurring.

There are four essential characteristics in mental application which should be considered in determining its amount. *Initiative* is mental resourcefulness, analytical ability, and power of decision. It is especially significant in new situations. *Adaptability* is versatility and competence in fitting into new situations. It is the opposite of narrow and patterned thinking. *Judgment* is the ability to make decisions which fit with consequences. It is foresight and prudence in making decisions. *Mental alertness* refers to the attention and vigilance which some jobs require to avoid errors. When each of these characteristics is considered in the analysis of a job, the "mental application" factor has been pretty well covered.

Again, it is important for the analyst to be exact and specific in describing what the worker must do in his exercise of mental function. What plans must he formulate? What decisions must he make? What new situations must he adjust to?

Dexterity and Accuracy. This factor concerns the degree of manipulative ability necessary for the precisions required. It is measured by the degree of difficulty of maintaining accuracy, the number and type of movements, the repetitiveness of the job, and the required precision of movements. The amount of dexterity is not always indicated by the tolerance allowed. It is easier to achieve $\frac{1}{100}$-in, tolerance on an engine lathe than $\frac{1}{32}$ in. in the use of a carpenter's hand tools. The dexterity necessary to maintain the latter tolerance is greater than that necessary for the former. A good job description will not only state the accuracy required but also the condition necessary for its attainment. The consequences of inaccuracy should also be stated.

COMMENTS

In any job analysis there is collateral or supplementary information which does not seem to fit into any other category in the schedule.

The "comments" section is intended for such information. Often there is something unusual about the equipment or the materials which is significant in interpreting other parts of the analysis. Perhaps a machine should be described for a reader who in all probability would be unfamiliar with it. Often a process is peculiar to a particular job and must be explained so that the description of the work performed will be meaningful. Perhaps there are instruments used which would be unknown to the naïve reader. In the illustration given above, the bevel protractor was mentioned. That instrument should be described and its function explained in this section of the job analysis.

Technical terms are often used in describing the work performed. They should be defined in this section. For example, the word "charging" is used in one of the illustrations given above. The meaning of this word is not the usual one given in the dictionary. The word "die" is used in another illustration. The "comments" section of a job analysis schedule should define every word used which would not likely be understood by the potential reader.

Physical Demands

The handicapped, war-disabled, women, youth, and aged are limited in physical capacity. They must be placed in jobs which are less demanding in this respect. If the physical demands of a job are too great, a workman is unadjusted before he begins. This item in job analysis should contain detailed information regarding the activity performed, its frequency, the strength it requires (in pounds and distance if it is a weight moved), the working condition under which it is performed, and the hazards or dangers involved. The government provides a special blank for this part of the job analysis, consisting of a check list of 27 physical activities and 27 working conditions which are marked "X" if present in the job and "O" if not. The hazards are described in detail and the per cent of time exposed to each is indicated.

In a sense, this item is coordinate with and supplementary to the four factors considered under performance requirements. It rounds out the job picture in regard to job difficulty. All these factors—responsibility, job knowledge, mental application, dexterity, and physical demand—are especially significant when the job analysis is used in job evaluation.

Characteristics Required of a Worker

This item in the job analysis schedule is of special significance in vocational adjustment. It enables a worker to judge beforehand whether or not he possesses the characteristics necessary for a particular job. It also enables the employer to predict more accurately how well a workman will adjust to a job. Recently a large steel plant needed three new workmen for Brinell testing. This is a simple job which can be learned in a short time, but it is highly repetitive and demands accuracy. The following brief description is copied from the job analysis files of this company.

> Repetitive work. Follows standardized procedure. Tests forgings for hardness. Sets forgings in place. Lowers press platen and applies pressure. Reads diameter in millimeters of impression with Brinell glass. Makes record of test. Stamps hardness identification on forging. Notifies heat-treat foreman when hardness does not conform to specifications.

The job description also stated that the job demanded a superior degree of "keenness of vision" and an above-average degree of "accuracy." The two men and one woman selected for the job were handicapped in characteristics for most other jobs in the plant but possessed the needed characteristics.

The government uses a "Worker-characteristic Form" which lists 47 characteristics. These are each marked with the degree necessary for the performance of each job analyzed. The degrees are as follows:

O—Not required for the job.
C—A low degree required.
B—An above-average degree required.
A—A very high degree required.

Along with the worker characteristics listed on this form, the estimated per cent of jobs requiring each characteristic is given in parentheses:

1.	Work rapidly for long periods	(24)
2.	Strength of hands	(24)
3.	Strength of arms	(31)
4.	Strength of back	(19)
5.	Strength of legs	(6)
6.	Dexterity of fingers	(22)
7.	Dexterity of hands and arms	(37)
8.	Dexterity of foot and leg	(2)
9.	Eye-hand coordination	(42)
10.	Foot-eye-hand coordination	(7)
11.	Coordination of both hands	(6)
12.	Estimate size of objects	(7)
13.	Estimate quantity of objects	(6)
14.	Perceive form of objects	(14)
15.	Estimate speed of moving objects	(2)
16.	Keenness of vision	(21)
17.	Keenness of hearing	(2)
18.	Sense of smell	(1)
19.	Sense of taste	(1)
20.	Touch discrimination	(5)
21.	Muscular discrimination	(11)
22.	Memory for details (things)	(17)
23.	Memory for ideas (abstracts)	(5)
24.	Memory for oral directions	(3)
25.	Memory for written directions	(2)
26.	Arithmetic computations	(8)

27. Intelligence .... (10)
28. Adaptability .... (4)
29. Ability to make decisions.... (7)
30. Ability to plan............. (9)
31. Initiative .... (7)
32. Understanding mechanical devices .... (11)
33. Attention to many items.... (14)
34. Oral expression............ (2)
35. Skill in written expression... (1)
36. Tact in dealing with people.. (8)
37. Memory of names and persons. (2)
38. Personal appearance........ (3)
39. Concentration amidst distraction .... (2)
40. Emotional stability.......... (3)
41. Work under hazardous conditions .... (13)
42. Estimate quality of objects... (9)
43. Unpleasant physical conditions .... (21)
44. Color discrimination........ (4)
45. Ability to meet and deal with public .... (5)
46. Height
47. Weight
48. ______________________
49. ______________________
50. ______________________

There is other information which is sometimes obtained in job analysis For example, if the analysis is being used to establish wage rates it may be necessary to make a time study. However, for the purpose of occupational adjustment the above schedule is adequate. It will tell the individual enough about the jobs in an occupational field to enable him (or his adviser) to determine if he is interested and if he has the necessary qualifications. More often some of the items are omitted when this is the only use made of the analysis.

To illustrate variations from the job analysis schedule just described, the one used by the Lockheed Aircraft Corporation[9] is as follows:

1. Work Performed—Type of operation; class of work; purpose of operation; where operation is to be performed; necessity for operation.

2. Operation Procedure—Size of work crew; description of material flow to work place; master list of elements in sequence for setup, operation, and tear-down; short analysis of how operation and crew combine, or how operator or operators work during the cycle.

3. Floor Plan—Speed sketch of workplace and work area to scale on an 8½ × 11-inch sheet.

4. Materials—Type; kind; range of gauge; gauge and size raw; gauge and size finished; heat-treat condition of material received; weight of raw material handled; weight of finished piece handled; defects; shape in which material is used; how material must be handled; per cent of scrap; scrap pattern (sketch); how scrap is handled and stored; per cent salvable; how material is delivered to machine; in what quantities material is delivered.

5. Jigs or Fixtures—Names and description; how used; number of operations performed; handling percentage to operation; condition of

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[9] Trumpis, R. A., Time Study Procedure, *Fact. Mgmt.*, 1942, **100**, 89–96.

tools; how handled; how material is held in place; how cleaning is done when piece is worked on or finished; weight.

6. Specifications—Tolerance of work; inspections required; danger of spoilage; causes of spoilage; care required to handle part; care required to handle raw material; finish required.

7. Machine Tools—Name; type; capacity range; tolerance possible; operation performed; maintenance required per 8-hour day; range of speeds, feeds, etc.; number of men required to operate; efficiency of equipment.

8. Hand Tools—Name of tools.

9. Workbenches and Storage Facilities—List of workbenches with full description of use, size, etc.; points at which materials are stored for operation; how raw material is stored at machine or workplace; how raw material is stored at main storage; how finished material is stored at point of operation.

10. General Job Conditions—Light; air; housekeeping; general surroundings and influencing factors; aisle space; equipment layout; fatigue-causing factors; hazards; interruptions; operator's work position; care required to perform operation; condition of tools, jigs, fixtures.

A less typical job analysis schedule is used by the University System in the state of Georgia for analyzing nonacademic jobs. Preliminary information is obtained by mail, as indicated by the job questionnaire reproduced at the end of this chapter. This information is later checked by interview and investigation. The entire purpose of this analysis is to obtain information for job evaluation and classification.

SUMMARY

A detailed and systematic inventory of all characteristics of a job is valuable for use in hiring, training, job evaluating, job simplifying, safety, reducing monotony, etc. Job analysis is too often neglected by those who make decisions regarding jobs. It is the first step in an intelligent approach to any problem regarding jobs. It is not so important what job analysis schedule is followed as it is that the analysis be thorough and accurate.

UNIVERSITY SYSTEM
STATE OF GEORGIA
Nonacademic Job Questionnaire

The University System has found it advisable to determine the full content of its nonacademic jobs as a basis for classification. In order to do so, we are requesting all employees to describe just what they are doing, of what their respective jobs consist, and the amount of knowledge, skill, experience, and responsibility required thereof. Your careful preparation of the information asked in this questionnaire will be of great help to your University System in its attempt to classify and describe accurately the various positions.

Please read this entire questionnaire over carefully *before* answering any of the questions. Do not leave any questions blank. Answer each question as specifically and as completely as possible. If a particular question does not apply to your job, do not leave that question blank—fill in the words "none," "no," "does not apply." This information is for a person not familiar with the duties of your position or your department. Make your information sufficiently clear to be understood by such a person. If you do not understand any question, contact your supervisor. Add any additional information you think we should know about on the back of this questionnaire.

This questionnaire is *not* intended to obtain any information about the particular person holding a particular job. We desire only information about the job itself.

Your wholehearted cooperation is earnestly requested.

Institution____________________ Department________________

Name of employee____________________ Title of position________________

Name of Immediate supervisor________________ Title of his or her position________________

Note: Questionnaires for maintenance and service jobs should be filled out by immediate supervisors. Do not fill out a questionnaire for *every* employee. When several employees perform the same duties there is just one job and but one questionnaire is necessary.

I. Description of the Duties of Your Position:

A. Daily duties (in answering this question be sure to include all those duties in your daily routine). Approx. hr. per day

____ ________

____ ________

____ ________

____ ________

Total ________

B. Regular, periodic duties (weekly, monthly, etc.). Approx. hr. per week

____ ________

____ ________

____ ________

____ ________

Total ________

C. Occasional duties at irregular intervals.

____ ________

____ ________

D. No duties at all (during working hours). ________

E. What is the general purpose of your work?____________________

____

____

F. How many hours per week are you required to work?____________

G. Do other employees perform the duties described above?____________

If so give names.____________

II. Educational Requirements of This Job:

What education you think your job requires—not how much you may have? (Check.)

( ) Grade school (or less)—read, write, add, subtract, janitor, grounds laborer.

( ) 1—2 years high school—simple arithmetic, checking, posting etc.

( ) 3—4 years high school—ordinary clerical, typing, etc.

( ) High school and business school—higher type clerical, bookkeeping, secretarial.

( ) Partial college 1—3 years—knowledge of specific field—accounting, engineering, etc.—or practical knowledge required to interpret complicated drawings and manufacturing methods.

( ) College graduate—technical background (advanced knowledge of accounting, engineering, chemistry, etc.) required to understand complicated subjects.

III. Experience and Training Required for Your Position:

Consider what you think should be the combined amount of previous experience and training required to fulfill your position. (Check.)

Months			Years					
0	3	7	1	3	5	7	9	11
( )	( )	( )	( )	( )	( )	( )	( )	( )

How long have you been on this job?____________ (If *previous* experience is included above, then describe your own previous experience on the back of this page.)

IV. Extent to Which Work Is Supervised (Check):

( ) Immediate or frequent supervision. Day labor.

( ) Short assignments—supervised. Copy typing, simple filing.

( ) Little immediate supervision but follow standarized procedures in normal routine of work.

( ) Follow established procedures generally and refer only unusual cases to superior. Department secretary.

( ) Broad assignments, procedures not standardized; usually with little guidance or checking. Rarely refer to superiors except as a matter of policy

( ) Organize own work, assign and check work, rarely refer specific problems to supervisors.

( ) Under administrative direction, set up own standards of performance: virtual self-supervision.

If you are required to exercise independent judgment without supervision, give a typical example of such a situation.

____

____

V. Dexterity and Manual Accuracy:

To what extent does the job require the use of the fingers, hands, arms, and/or feet to function in coordination with the senses (seeing, hearing, etc.) so that movements will be accurate and dexterous? (Check.)

- ( ) No motor skill.
- ( ) Moderate skill—such as operating adding machine.
- ( ) Repetitive—such as typing, driving car.
- ( ) Varied skills—such as carpenter, plumber.
- ( ) Highest level skill—such as airplane pilot.

VI. Working Conditions (Check):

- ( ) Ideal—air conditioned.
- ( ) Ordinary—inside. Heat in winter; fans in summer.
- ( ) Inside about half-time; outside half-time.
- ( ) All outside work.
- ( ) Bad—noise, dust, fumes, or some other disagreeable factor.

VII. Physical Effort (Check):

- ( ) Mostly sitting—typical of office jobs.
- ( ) Some physical effort—typical of truck operator, messenger, night watchman.
- ( ) Ordinary for manual work—typical of carpenter, furniture repairman.
- ( ) Considerable physical effort—typical of ditch digging.
- ( ) Great physical effort—coal shoveler.

VIII. Mental and/or Visual Effort:

How alert and attentive must employee be? (Check.)

- ( ) Little or no attention ncessary—manual labor, yardman.
- ( ) Occasional, or routine, attention—painter.
- ( ) Average attention—typist, truck driver.
- ( ) Considerable attention—secretary.
- ( ) Success depends on mental effort—supervisor, manager.
- ( ) Greatest mental effort yet not enough—policy-making jobs.

IX. Hazards:

What accident and/or health risks are necessary? (Check.)

- ( ) None—office jobs.
- ( ) Minor injuries possible—ordinary manipulative jobs—fireman, policeman.
- ( ) Time-loss injuries may occur—handling machinery and apparatus—plumbing, carpentry.
- ( ) Major accidents possible, minor accidents frequent—caution very important—electrician.
- ( ) Great—unlikely on college or university campus.

X. Responsibility—for Materials, Tools and Equipment:

Negligence may result in how much damage?

- ( ) None—typist.
- ( ) Less than $10—yardman.
- ( ) From $10 to $50—truck driver, plumber.
- ( ) From $50 to $250—handles expensive apparatus.
- ( ) Above $250—unlikely.

XI. Responsibility—For Reports and Records:

This does not refer to the typing of reports and records but to the responsibility for keeping them and making them out for typing. (Check.)

- ( ) None.
- ( ) Simple time record—assistant foreman.
- ( ) Several types of simple records—foremen.
- ( ) Yearly reports with patterns and precedents to guide—section supervisors.

( ) Complex records and yearly reports of new functions—general supervisors.

XII. Responsibility—Contacts with Others:

To what extent is the relationship with other people a part of your job? (Check.)

( ) None necessary to job.
( ) Only with supervisor and fellow workmen—typist, yardman.
( ) With both faculty and students but for exchange of information only—secretary.
( ) Contacts of persuasive nature—to influence others—foremen, supervisors, managers.
( ) Reputation of institution depends on effectiveness of employee in this job. Public relations a part of job.

XIII. Responsibility—Money and Securities:

How much money and securities are you responsible for at any one time? (Check.)

( ) None.
( ) Up to $25—secretary with petty cash.
( ) From $25 to $100.
( ) From $100 to $500.
( ) More than $500.

Are you bonded?____________________ If so, for how much? $__________

Do you have authority to release these funds without specific superior approval for each transaction? ( ) Yes ( ) No.

XIV. Confidential Data:

To what extent does your position require working with confidential data?

	None	Limited	Moderate	Considerable
1. Wages and salaries	( )	( )	( )	( )
2. Costs	( )	( )	( )	( )
3. Financial statements	( )	( )	( )	( )
4. Contracts data	( )	( )	( )	( )
5. Others (list)	( )	( )	( )	( )

XV. Supervision of Others: None ( )

Answer *A* and *B* only if you supervise others.

A. Character of supervision. Consider here the nature of the supervision; responsibility for disciplining, hiring, transferring, etc., or is it merely assigning and checking work, or acting as understudy to a supervisor? If totally responsible for any of the following, insert "T" in the block preceding item; if partly responsible, insert "P"; if not responsible at all, insert "N."

( ) Assigning work
( ) Checking work
( ) Hiring
( ) Transferring
( ) Disciplining
( ) Costs
( ) Methods
( ) Personnel
( ) Grievances
( ) Planning
( ) Routing
( ) Scheduling
( ) Quality standards
( ) Quantity standards

B. Number of employees supervised.

Insert exact number for each degree of supervision.

Totally responsible for work of ( ) employees.

Partly responsible for work of ( ) employees.

XVI. Management of Materials and/or Processes:

Describe here any management of *material* and *processes* you may be responsible for. Do not include the supervision of personnel.

____

____

____

____

XVII. Wages or Salary:

What is your salary or wage per week______ or month________?

Note: If this questionnaire does not include all essential information about the duties of your job, please describe those on the back of this page.

To Be Filled in by Supervisor of This Job: (Then return to Comptroller's office.)

I have checked this questionnaire and have made necessary corrections. The information now contained is accurate.

____

Supervisor

RECOMMENDED READINGS

BELLOWS, R. M.: *Psychology of Personnel in Business and Industry,* Chap. 4, Prentice-Hall, Inc., New York, 1949.

HARRELL, T. W.: *Industrial Psychology,* Chap. 2, Rinehart and Co., Inc., New York, 1949.

SHARTLE, C. L.: *Occupational Information,* Chaps. 2–3, Prentice-Hall, Inc., New York, 1946.

VITELES, M. S.: *Industrial Psychology,* Chap. 9, W. W. Norton & Co., Inc., 1932.

War Manpower Commission: *Manual for Job Analysis,* Government Printing Office, Washington, D.C., 1944.

Chapter 3

WORKER ANALYSIS

- Interest Measurement
  - Interpretation of Past Experience
  - Interest Tests
    - Strong's Vocational Interest Test
    - Kuder's Preference Record
- Personal Data Evaluation
- Aptitude Analysis
  - Intellectual Aptitude
  - Mechanical Aptitude
    - Mechanical Comprehension
    - Mechanical Assembly Tests
    - Dexterity
    - Space Perception
  - Clerical Aptitude
  - Aptitude Combinations
    - Medical Aptitude
    - Nursing Aptitude
    - Engineering Aptitude
    - Sales Aptitude
    - Teaching Aptitude
    - Law Aptitude
- Summary

When an occupational analysis is complete—when an overview has been made and the various jobs in the occupation analyzed—and the individual is apparently interested in that occupation, the next step is to discover if he has the necessary qualifications or can acquire those qualifications with reasonable effort. This means that he must be analyzed. The individual's motivation alone is not enough. Regardless of how much he may want to become a physician, for example, and how hard he may try, he must also have those human qualifications necessary for graduating from medical school, passing state medical examinations, and treating ill people with a fair degree of success. His own opinion of his qualifications is not enough. Scientific evidence of the degree of his qualifications should be obtained.

The scientific analysis of human abilities is a difficult procedure and must be performed by those who are well-trained in psychometric techniques. It is not enough to administer and to score a test. The score must be interpreted accurately. This necessitates an acquaintance with the norms (and the subjects and conditions used in obtaining them), the degree of test accuracy or reliability, the validity of the test for the use now being made of it, the significance of the score in relation to scores on other tests, the appropriateness of the test for the individual being studied, and the relation of the test to other means of ability diagnosis. It is important for the vocational psychometrist to know what tests are available and which ones should be used in ability analysis for a particular occupation. He must also be skilled in the use of statistical techniques and be able to calculate the significance of tests when they are used in new situations. In short, methods of scientific analysis of human abilities are of value only when used by those who are trained for their proper use and interpretation.

INTEREST MEASUREMENT

The first step in ability analysis is to check on the accuracy of the individual's statement of his vocational interests. Before time and effort are spent to find out if a man is fitted for a job, it should be verified that he really wants it and would in all likelihood be satisfied if he got it.

Vocational interest is measured or indicated by two methods—the interpretation of past experience and the expression of likes and dislikes. The former is nonmetrical and depends on the subjective evaluation of the examiner. The latter involves the administration of tests and results in a metrical index.

Interpretation of Past Experience

Information about past experience is usually obtained by a rather patterned interview in which predetermined questions are asked, or by a questionnaire which is filled out by the job applicant. These questions concern past employment, schooling, leisure-time activities, and ambitions for the future. The following questions are typical.

What work have you done?
What promotions did you receive?
What courses did you take in school?
What grades did you receive in each?
What outside reading have you done?
What are your hobbies?
If you could choose, what would you like to be doing ten years from now?
What organizations do you belong to?
What magazines do you read?
Etc.

The assumption is that one does what interests him most. If information can be obtained about what a man has done, it will generally provide a fair indication of his interests. If he has always had a home shop, if he has excelled in shopwork in school, earned Boy Scout merit badges for manual skills, done minor repairwork around his home, read books and magazines about handicrafts, made plans to equip his home shop with small power tools—it certainly is indicative that he is interested along mechanical lines. On the other hand, if his activities have been of a leadership nature—such as being manager of his high school football team, organizer of some youth group (for camping, athletics, social events, etc.), chairman of various committees, spokesman for some protest group, superintendent of a Sunday school, executive secretary of a philanthropic group—it is obvious that his interests are in some managerial direction and his greatest efforts would be expended in work of that nature. Probably neither man suggested above would be happy or successful on a job which did not involve function along the line of his major interest. His ability to adjust to a job of a foreign nature would depend somewhat on the dominance of his specialized interests.

Usually it takes a trained interviewer to discover an applicant's real interests. If a man wants a job strongly enough he will pretend appropriate interests. He may even be deceptive in reporting facts of his past experience. All such items should be verified for accuracy. If the position is on a major level, it is well to have the applicant interviewed by several trained and experienced interviewers.

Often the past experience of a man is so varied and unrelated that there is no clear picture of specialized interests. Apparently he has no specialized interests. It is then necessary to use other methods of interest diagnosis.

INTEREST TESTS

As indicated above, a person's interests are indicated by his likes and dislikes. If a survey is made of his likes and dislikes for a large number of occupational components and the results compared with the likes and dislikes of successful people in various occupational fields, an index of the degree of interest in a vocational field may be obtained. For example, if a man expresses a dislike for 10 out of 15 activities associated with music, and if this is entirely dissimilar to the expressed likes of musicians, it may be concluded that he has a low level of interest in music. On the other hand, if he expresses a liking of 23 of 25 activities associated with salesmanship, and if this is in harmony with the likes of successful salesmen, it may be concluded that he is interested in salesmanship.

There are a number of published tests which survey occupational interests. They have varied degrees of reliability and validity. Two of the more widely used interest tests are by Strong and Kuder.

Strong's Vocational Interest Test. This is one of the earliest and most carefully studied tests of interest. There is a form for men and another for women. A large number of occupational activities (400 on the 1938 form for men and 410 on the 1933 form for women) are listed and the applicant is asked to indicate whether he likes, dislikes, or is indifferent to each. The test is then scored for the degree of similarity to the likes and dislikes of successful men in 35 different occupations and of successful women in 19 different occupations. An "A" or "B-plus" degree of interest is significant but degrees below this (B, B minus, C plus, and C) indicate very low or no interest.

The test is difficult to score and is usually sent to some scoring center for machine scoring. It has the further handicap that it is easy for an applicant, who wants his interest score to conform to that needed for a particular job, to mark the test erroneously. Consequently, it is not generally used in employment situations except when the job is sufficiently important to warrant careful selection. Then, it is often used to check on some other interest test. It is frequently used by schools and veterans' bureaus in vocational counseling.

Kuder's Preference Record. This test consists of 168 groups of three occupational activities each. The applicant is instructed to indicate which of the three activities he likes most and which he likes least. He may like all three in some groups and dislike all three in others, but he must choose the activity in each group that he likes most and the one he likes least. The following two groups illustrate the nature of the test.

Visit an art gallery.
Brouse in a library.
Visit a museum.

Collect autographs.
Collect coins.
Collect butterflies.

This test is easily scored, even by the applicant himself, and the results are graphically shown on a "profile sheet." The degree of interest above and below the average (50th centile) is indicated for nine occupational fields. These are:

1. Mechanical
2. Computational
3. Scientific
4. Persuasive
5. Artistic
6. Literary
7. Musical
8. Social service
9 Clerical

There are separate norms for men and women but both take the same form. Mean profiles are given for men in 26 occupations and for women in 23 occupations. Median and quartile scores for each of the nine occupational fields are given for men in 44 occupations and for women in 29 occupations.

The manual (1946) gives classifications of occupations in the nine interest fields and in 36 combination fields. For example, a combination of mechanical and persuasive interests would include such occupations as building contractor, communications foreman, filling-station attendant, purchasing agent for a manufacturing concern, salesman of mechanical equipment, and supervisor of auto-repair shop.

This is the most widely used of all interest tests. It has high reliability on all nine scales and low intercorrelations between the scales.

PERSONAL DATA EVALUATION

When it is established that a job applicant has adequate interest in an occupation, it is then important to evaluate his age, his training, his obligations, his experience, and other items of personal data. This necessitates a careful review of the job analyses within the occupation so that the human characteristics required are definitely in mind. The usual procedure is to obtain information of a personal nature by interviewing the applicant and then to evaluate this by subjective opinion, sometimes by several members of the managerial staff. A better procedure is to evaluate such information by predetermining the worth of each item experimentally and then attaching a metrical value to it. The sum of these values then constitutes a score which can be compared to that of other applicants and to that of present employees.

The procedure of weighing items of personal data necessitates a study of those items and their significance in the present employed personnel. If an item is characteristic of present successful employees and not characteristic of those who are least successful or were released as unsatisfactory, it is probable that the item is important. For example, if 87 per cent of present successful employees are married and only 37 per cent of those who are inefficient are married, it would seem that marriage is a significant item. However, if approximately the same percentage of satisfactory as of unsatisfactory employees are married, the item is of no significance in selecting new employees (see Table 3–1 and compare with Table 3–2).

TABLE 3–1. PER CENT OF PERSONAL ITEMS AT TIME OF EMPLOYMENT AMONG SUPERIOR AND INFERIOR WORKMEN IN THE INSPECTION AND SALVAGE DEPARTMENT OF A STEEL PLANT

Item	Superior workmen	Inferior workmen	Difference	Weight or value
Age:				
Below 25	67	58	9	0
25 to 35	26	28	−2	0
Above 35	7	14	−7	0
Married	43	47	−4	0
Dependents:				
0 or 1	66	79	−13	0
2 or more	34	21	13	0
Education:				
8th grade or less	73	64	9	0
9th grade or more	27	36	−9	0
Own home	31	16	15	0

A simple method of determining the weight of each item of personal data is to compare a group of superior employees with a group of inferior employees, and then weight items of personal data in terms of the difference in per cent of the item found in the two groups. This method is illustrated in Tables 3–1 and 3–2. In Table 3–1, the "successful" employees were the upper 25 per cent and the "unsuccessful" employees were the lower 25 per cent, as determined by merit rating. The work was in a steel plant and most of the jobs were on a semiskilled level. However, none of the differences were great enough to carry weight. Two or more dependents, eighth-grade education or less, and home ownership were all fairly large but percentage differences of less than 20 are not usually used to weight items even if they are statistically significant.

In Table 3–2, the weights were more significant. The "advanced" employees were those who had been given at least one promotion or salary increase per year since employment, and the "static" employees were those who had averaged but one promotion or less in 3 years. The middle group was not considered.

TABLE 3–2. PER CENT OF PERSONAL ITEMS AT TIME OF EMPLOYMENT AMONG ADVANCED AND STATIC EMPLOYEES IN THE ENGINEERING DEPARTMENT OF A STEEL FABRICATING PLANT

Item	Advanced	Static	Difference	Weight or value*
Married	53	31	22	2.2
Education:				
8 years or less	5	10	−5	
9 to 12 years	15	45	−30	−3.0
13 years or more	80	45	35	3.5
Dependents:				
1 or more	93	58	35	3.5
None	17	42	−35	−3.5
Own home	13	18	5	
Age:				
Below 25	85	40	45	4.5
26 and up	15	60	−45	−4.5

* Whether or not a difference in percentages is to carry weight is determined by both its size and its statistical significance. A large difference may or may not be statistically significant. The formula for determining this is:

$$\frac{\text{Diff.}}{\sqrt{\frac{P_1Q_1}{N_1} + \frac{P_2Q_2}{N_2}}}$$

P refers to the percentage with the characteristic and Q to the remaining percentage. For example, the statistical significance of the first difference in the above table is calculated as follows:

$$\frac{22}{\sqrt{\frac{53 \times 47}{82} + \frac{31 \times 69}{64}}} = \frac{22}{\sqrt{63.8}} = 2.8$$

It is a simple matter to evaluate the qualifications of an applicant for a job when the weights of various factors have been determined in some manner similar to that described above. When these weights are considered in selecting and placing men, there are fewer "failures." Life-insurance companies frequently use such methods in selecting salesmen. Russell and Cope[1] found that when successful life-insurance salesmen were compared with unsuccessful life-insurance salesmen on a scale of experimentally weighted personal factors, the successful salesmen in general were distributed higher on the scale than were the unsuccessful salesmen. This distribution is shown in Table 3–3. If the scale had been used in selecting the salesmen and 641 had been used as the "critical score," which was later adopted, 31 per cent of the failing salesmen would not have been hired.

[1] Russell, W., and Cope, G. V., A Method of Rating the History and Achievement of Applicants for Positions, *Publ. Person. Stud.* 1925, 3, 202–219.

TABLE 3–3. PERCENTAGE DISTRIBUTION OF SCORES ON A WEIGHTED PERSONAL-DATA SCALE FOR SUCCESSFUL AND UNSUCCESSFUL LIFE-INSURANCE SALESMEN

	579–640	641–670	671–732
Successful salesmen	0	24	76
Unsuccessful salesmen	31	42	27

Many companies have space on their application blanks for filling in the weights of various factors. These are then totaled and compared with a distribution chart of present employees weighted in the same manner. Table 3–4 illustrates an application blank of this nature. Note that only that information is obtained which has known or weighted value. A workman's application-blank score is a valuable factor to be considered in his employment and placement.

TABLE 3–4. AN APPLICATION BLANK WITH WEIGHTED VALUES

Name ______________________________
Address ______________________ Phone __________
Date of birth ______________________ ( )
Present employer ______________________ ( )
Dates employed in
last 5 years ______________________ ( )
Number of employers
in last 5 years ______________________ ( )
Married __________ Single __________ Divorced __________ ( )
Number of dependents ______________________ ( )
Amount of savings or investments ______________________ ( )
Education in years:
Grade __________ High School __________ College __________ ( )
Own home __________ Rent __________ Board __________ ( )
Total ( )

APTITUDE ANALYSIS

The success of any company depends on the qualifications of its present employees, but the future success of a company depends on the potentialities and aptitudes of its young employees. Consequently, men must be employed, not only for their present worth, but also for their capacities for future growth. A large steel-fabricating company has a policy of hiring "young men of promise," regardless of their present qualifications or of the company's immediate need for their services. Men are employed for their aptitudes.

Aptitude is defined in Warren's *Dictionary of Psychology* as "a set of characteristics regarded as symptomatic of an individual's ability to acquire with training some knowledge, skill, or set of responses." It must be distinguished from ability—or that which "can now be done with present training and development." Ability is a present status, while aptitude is the prospect for learning and developing a future status.

Aptitude, however, is more difficult to measure than it is to define. In reality, only ability can be measured, and from that, aptitude must be assumed or predicted. All aptitude tests are measurements of abilities, but of only those abilities which have been found to be predictive of the capacity to learn and develop. In other words, some ability tests are used to predict aptitudes, and are therefore called aptitude tests.

Man has many aptitudes; but what they are, how they should be classified, how they should be determined, and what their significance is in various phases of human endeavor are moot questions. Some aptitudes—such as music and art—can be measured with a fair degree of accuracy, but they are not significant in usual employment situations. Other aptitudes—such as social intelligence and ambition—are fundamentally significant in employment but cannot be measured with sufficient accuracy to justify the effort. Those aptitudes which are both vocationally important and measurable are described in the following pages.

INTELLECTUAL APTITUDE

Intelligence has been variously defined as the capacity to learn, to solve problems, to adjust to novel situations, to do abstract thinking, to reorganize experience into new patterns, to recognize truth or fact, to comprehend cause and effect relationships. In a practical industrial or business situation, the word "intelligence" is used to include all these types of behavior. It is a general term that refers to superior mental function. The intelligent workman is able to "see through" complicated problems, to predict consequences accurately (so that he avoids "boners"), to learn quickly to comprehend and follow instructions accurately, and to decide when standard procedures are not appropriate (so that he can either control the condition himself or report it to a superior). The degree or amount of a workman's intelligence is indicated by the difficulty of the problems he is able to solve.[2]

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[2] Difficulty refers to the proportion or number of people who can perform the behavior. A problem that can be solved, or an act that can be performed, by 50 per cent of a given group of workmen is not so difficult as one that can be solved, or performed, by only 10 per cent.

Tests to measure intelligence are varied in nature and in purpose. Some are given by interview but more frequently they are printed questions which are to be answered by checking the right answer from a check list. The number of right answers, called a "raw score," is interpreted by comparing it with a "table of norms." This is a distribution of raw scores made by other people on the test. A score that is higher than that made by 95 per cent of others who have taken the test but lower than that made by 4 per cent is said to be in the 96th percentile. This is a high score if the "other people" are appropriately comparable. It is very important to use norms obtained from the scores of people who are similar in essential respects to the one whose score is being interpreted. The manual which accompanies an intelligence test usually contains several tables of norms made up from special groups—students of various levels, industrial groups, business groups, etc. A score may have a high rating on one set of norms and a low rating on another. Cook and Barre[3] found that when the Minnesota Rate of Manipulation Test was used in an industrial situation the norms (made up from scores of college students) were too low. A new table of norms (which the authors labeled "industrial") varied from the old as much as 40 per cent at some levels. A woman's score of 233 would place her at the 50th percentile on the test-manual norms and at the 6th percentile on the Cook-Barre norms. Any sort of test scores can be properly interpreted only with appropriate norms.

To determine the worth of an intelligence test for a given employment situation, it is necessary to try it out on present employees to see if it distinguishes between those who are known to be superior in intelligence from those who are known to be inferior. It is always necessary to "test a test" before it is used in an employment situation. Procedures of doing this are complicated and should be attempted only by those with appropriate training.

Intelligence is not equally significant on all jobs. Some jobs require more than others. A crane operator must have more intelligence than his hook-on man. A bank cashier must have more than a manicurist. There are a number of published lists of occupations and the relative intelligence required. The Barr Scale of Occupational Status lists 120 occupations in order of the intelligence required in each. Army data from both

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[3] Cook, D. W., and Barre, M. F., The Effect of Specialized Industrial Norms on the Use of the Minnesota Rate of Manipulation Test as a Selective Instrument in Employment Procedure, *J. Appl. Psychol.*, 1942, 26.

World Wars indicate the intelligence possessed by individuals who were engaged in various occupations before joining the army.[4] Perhaps the most useful list of occupations indicating the degree of intelligence required is The Minnesota Occupational Rating Scale. Some 430 occupations are listed and the level of intelligence (as well as the level of mechanical, social, clerical, musical, and artistic abilities) is given for each.[5]

After it is established that intelligence is important in an occupation, the practical problem arises as to what test should be used. The best answer is: Whatever test works. Any test is on trial until it is proved to be of use in discriminating between those who will make good on the job and those who will not. This validity will, of course, be relative. No test will make such discrimination without error. Consequently, it is well to weight intelligence test scores for their importance. The method of doing this can be as simple as that described above in weighting personal data.

The specific tests used in the early stages of an experimental study will depend on a number of conditions—the time available for testing, the probable intellectual level of the applicants, the appropriateness of test norms, the tests used in other similar situations, the assistance available for administration and scoring, the general academic background of the applicant, etc. The Ohio State University Psychological Test, the American Council on Education Psychological Examination, and the Carnegie Mental Abilities Test are good for measuring the intelligence of high school graduates. (College norms are available.) The Otis Self-administering Test of Mental Ability, the Wonderlic Personnel Test and the Adaptability Test are shorter and more appropriate for those who have not graduated from high school. The Terman-Merrill Revision of the Stanford-Binet, the Bellvue Intelligence Scales (Wechsler), and the Detroit Tests of Learning Aptitude are given by interview and used when more diagnostic measurement is desired. The Revised Beta Examination is used to measure the mental ability of those who are unable to read.

All these tests require the services of specialists for their use and interpretation. Either a testing program should be introduced and established by one who is specially trained or it should be attempted. The average personnel director is unqualified and should not attempt to introduce the use of mental tests except under the close supervision of a qualified psychologist.

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[4] This is not necessarily an indication of the degree of intelligence *required,* however. An occupation (such as policeman) may require a great deal more intelligence than is possessed by a majority of those in it; while another (such as letter carrier) may require less intelligence than those in it now possess.

[5] The manual for using this scale is published by Science Research Associates, Chicago.

It should be emphasized that when psychological tests of any sort are used in business and industry to select and place men on jobs for which they are better fitted, *the tests must supplement and not supplant present methods*. Employment managers on the whole have done a fairly good job of employing and placing men. Certainly psychologists have not yet devised procedures which they would care to substitute for present employment methods. However, they have found supplements to employment and placement methods which, if properly used, will improve those methods. Intelligence tests, for example, can be used to "raise the batting average" of an employment manager in almost any situation.

Intelligence tests have been widely used in industry and with varied success. Harrell[6] compared scores on the Otis Self-administering Tests of Mental Ability with merit ratings of 42 textile-mill supervisors. He found the relationship low (r of .37) but useful as a minimum requirement for supervisory placement. However, the merit-rating method he used was of such questionable validity that the test may have been better than the criterion.

Tiffin[7] gave the Adaptability Test to a group of supervisory trainees in a rubber plant and compared the results with their status 6 months later. He found that none of those who scored below 5 on the test were supervisors 6 months later. Of those who scored 5 to 9, 40 per cent had been demoted or quit. In contrast, less than 15 per cent of those who scored 10 to 14 and less than 5 per cent of those who scored above 15 had been demoted or quit.

Stevens and Wonderlic[8] found that superior office managers (those seldom criticized) made higher scores on the Otis Mental Abilities Test than did those managers whose work was less satisfactory (those often criticized). The superior group omitted or missed 11.96 test items while the inferior group omitted or missed 22.56 items.

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[6] Harrell, W. T., Testing Cotton Mill Supervision, *J. Appl. Psychol.*, 1940, **24**, 31–35.

[7] Tiffin, J., *Industrial Psychology* (Rev. ed.), pp. 94–95, Prentice-Hall, Inc., New York, 1947.

[8] Stevens, S. N., and Wonderlic, E. F., The Relation of the Number of Questions Missed in the Otis Mental Tests and the Ability to Handle Office Detail, *J. Appl. Psychol.*, 1934, **18**, 364–369.

Davidson[9] administered the Bureau Test VI (of mental alertness) to 50 clerical workers at time of employment and 10 years later. He found a correlation of .89 between the two series of scores. He then classified the employees into three job levels (simple clerical work, complicated clerical work, and decision-making jobs) and found a correlation of .77 between this and the initial Bureau Test VI score, and .83 between this and the final test score.

MECHANICAL APTITUDE

Tests of mechanical aptitude are so varied and used for so many different purposes that it is better to discuss them in groups determined by their nature and function.

Mechanical Comprehension. Mechanical-comprehension, or knowledge, tests are usually pencil-and-paper in nature but may be either verbal or pictorial. Verbal items are illustrated in Table 3–5 and pictorial

TABLE 3–5. ITEMS FROM VERBAL MECHANICAL-COMPREHENSION TESTS

Check the right answer.

Calipers are used to measure ______ breadth; ______ diameter; ______ depth; ______ length.

A chuck is a part of a ______ lathe; ______ milling machine; ______ planer; ______ press.

Annealing is a process of ______ heating; ______ cutting; ______ hammering; ______ cooling.

A template is a ______ type of plate; ______ shaft; ______ tool; ______ pattern.

The protractor measures ______ weight; ______ angles; ______ length; ______ temperature.

Mark the following pairs "S" if they are the same and "D" if different.

Cam—eccentric ______
Cog—gear ______
Stud—strut ______
Rasp—reamer ______
Flange—fillet ______
Bevel—angle ______
Winch—vise ______
Drill—bore ______

If the statement is true, mark "T"; if false, Mark "F."

______ A scriber should be used on a plate surface.
______ Calipers are only valuable in cylindrical work.
______ It is not good practice to use a rule on any work where a tolerance of less than 1/64 in. is wanted.
______ The screw or spindle of a micrometer has 45 threads to the inch.
______ Feeler gauges are used to measure small gaps between two parts.
______ Go-no-go gauges are often used in inspection work.

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[9] Davidson, C. M., Permanency of Mental Alertness Measures, *J. Appl. Psychol*. 1938, 22, 307–310.

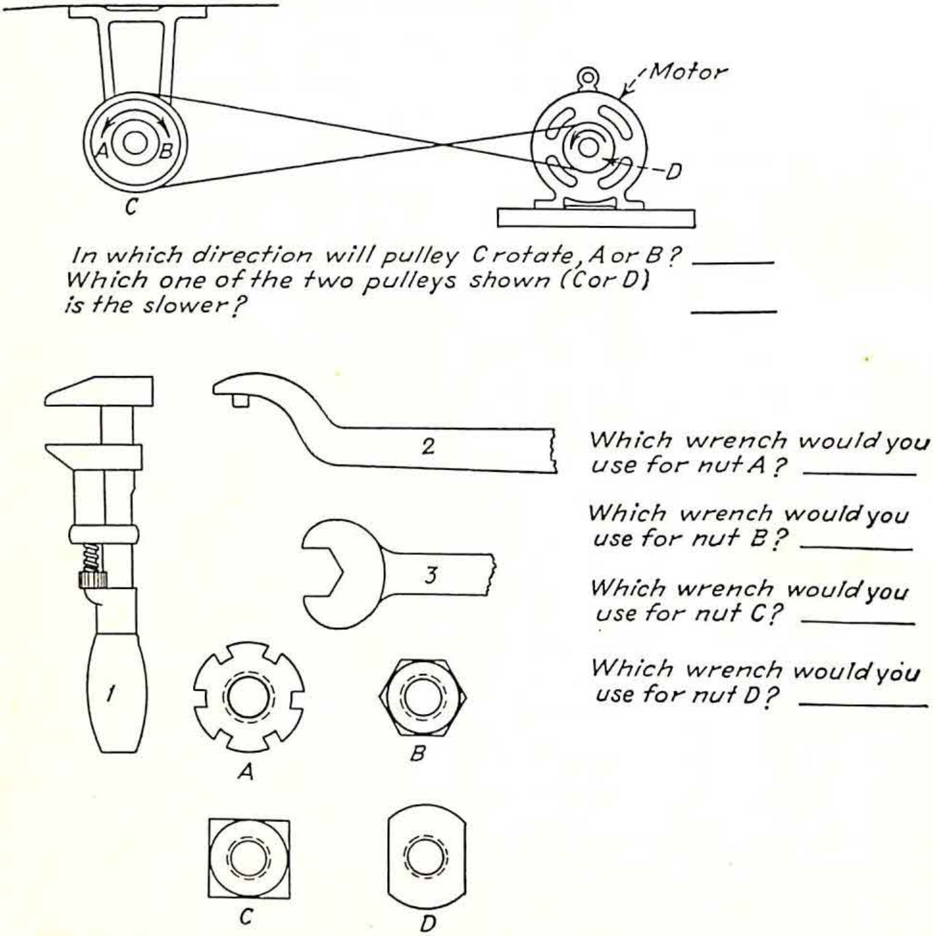
Motor
A
B
C
D
In which direction will pulley C rotate, A or B? ____
Which one of the two pulleys shown (C or D) is the slower? ____
1
2
3
A
B
C
D
Which wrench would you use for nut A? ____
Which wrench would you use for nut B? ____
Which wrench would you use for nut C? ____
Which wrench would you use for nut D? ____

FIG. 3–1. Sample items from pictorial mechanical-comprehension tests.

items are illustrated in Fig. 3–1. Most mechanical-information tests use items of both types, although pictorial items usually predominate. The following tests are entirely pictorial:

Bennett Test of Mechanical Comprehension.
Miller Survey of Mechanical Insight.
Lawshe Industrial Training Classification Test.
Stenquist Mechanical Aptitude Test.
Detroit Mechanical Aptitude Examination.
O'Rourke Mechanical Aptitude Test.

Mechanical Assembly Tests. As early as 1911, Healy and Fernald developed a puzzle box for measuring mechanical ability. The mechanism inside could be studied through a glass door and the door opened by the use of a button hook. Soon after the First World War, Stenquist developed an assembly test consisting of two boxes of ten small disassembled gadgets in each. The subject was asked to assemble these articles as quickly as possible. The score was a combination of both accuracy and time. The parts of each object were in separate compartments of the box. The following articles were used.

Box I

1. Cupboard catch
2. Chain
3. Mousetrap
4. Hunt paper clip
5. Bicycle bell
6. Shutoff
7. Lock No. 1
8. Push button
9. Clothespin
10. Wire stopper

Box II

1. Sash fastener
2. Rope coupling
3. Defiance paper clip
4. Expansion nut
5. Double-action hinge
6. Calipers
7. Elbow catch
8. Lock No. 2
9. Expansion rubber stopper
10. Pistol

Paterson and his associates at the University of Minnesota revised the Stenquist test and changed many of the articles used for assembly. They used three boxes of gadgets, nine in the first, eight in the second, and sixteen in the third. Scoring was more carefully controlled and the reliability, especially for boys, was increased.

More recently (1942), Graney at Purdue University has constructed a mechanical assembly test which differs from its predecessors in that it is equally unfamiliar to all subjects. It consists of eight boxes in which mechanical parts must be assembled in such a way as to produce specified mechanical functions. The articles are not familiar gadgets, as used by Stenquist and Paterson, but small parts which must be used in unique ways. The reliability is satisfactory and preliminary reports indicate possible usefulness in industrial situations.

All mechanical assembly tests are given individually and take more time than is usually available around an employment office. For this reason they are less frequently used than the group pencil-and-paper tests discussed above. However, they measure a different phase of mechanical ability and sometimes are necessary regardless of the time factor.

Dexterity. Finger and hand dexterity is sometimes called manipulative ability. Without question, it is one of the many factors measured by the mechanical assembly tests, but because it correlates so low with other human traits (such as intelligence and anthropometric measurements), it is usually measured separately. A number of very excellent dexterity tests are available.

The Minnesota Rate of Manipulation Test consists of 58 round wooden blocks, approximately 2 in. in diameter and an inch thick, and of a board 1 by 3 ft. in size in which there are 58 round holes. One part of the test consists of placing the blocks in the holes, and another part, of turning the blocks over. (The blocks are painted different colors on each side, *viz.*, red and green.) The score is the time required for these operations after one trial. The reliability is satisfactory, and the test has been found useful in selecting employees for certain jobs requiring hand dexterity.

Another test of finger dexterity is the Purdue Pegboard. It consists of a board of approximately 12 by 16 in. with two rows of small holes down the center. Part of the test is placing metal pegs in the holes, and another part is assembling a peg, a washer, a collar, and another washer using both hands alternately. The entire test can be administered in 5 minutes. It has been used extensively with good results.

Other tests of dexterity are the Hayes Pegboard, the O'Connor Tweezer Dexterity Test, the Crawford Small Parts Dexterity Test, the Bennett Hand-tool Dexterity Test, the Drake Pin Board Test, and the Pennsylvania Bi-manual Workshop.

Space Perception. Many jobs require the ability to judge space accurately and compare sizes, forms, and positions. The operator of an automobile must have a degree of such ability. A crane operator who is deficient in this ability is sure to be deficient in picking up loads and positioning them in close quarters without damaging material and equipment. Space-perception tests are of two kinds—form boards and paper space perception tests.

The form boards consist of wood or metal forms into which disarranged pieces are fitted, not unlike the procedure of fitting together the pieces of jig-saw puzzles. Typical tests of this nature are the Minnesota Space Relations Test, the Kent-Shakow Industrial Formboard, and the Dearborn Formboard 3.

Most of the paper space-perception tests are patterned after Part 7 of the old Army Beta Test. The general nature of this pattern is illustrated in Fig. 3–2. These tests may be given individually. Some of the more frequently used space-perception tests are the Crawford Space

Relations Test, the Case-Ruch Survey of Space Relations Ability, the Revised Minnesota Paper Form Board, and the Mitchell Drawing Aptitude Test.

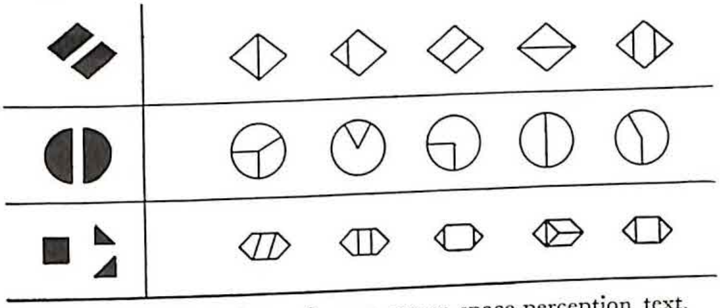

FIG. 3–2. Sample items from a paper space-perception text.

Space-perception tests have been found useful in selecting employees in a variety of industrial jobs. A number of years ago, Hall[10] found that by using the Minnesota Paper Form Board he could eliminate 69.6 per cent of inferior pressman apprentices at the sacrifice of only 6.2 per cent of those rated average and 5.7 per cent of those rated superior. Paterson[11] found great differences in scores on the Minnesota Special Relations Test (Form Board) between employees in various occupational groups. These are shown in Table 3–6. Note that 85 per cent of garage mechanics

TABLE 3–6. DISTRIBUTION OF SPACE-PERCEPTION ABILITY AMONG VARIOUS OCCUPATIONAL GROUPS

Group	*N*	Median centile
Garage mechanics	102	85
Manual-training teachers	170	75
Ornamental ironworkers	62	69
Men office clerks	113	66
Draftsmen	20	59
Minor bank officials	29	59
Retail salesmen	84	55
Life-insurance salesmen	47	55
Occupationally unselected men	489	50
Minor executives	26	46
Janitors	69	30
Policemen	124	27
Casual laborers	33	2

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[10] Hall, O. M., An Aid to the Selection of Pressman Apprentices, *Person. J. X.*, 1930, 9, 77–81.

[11] Paterson, D. G., Schneidler, G. G., and Williamson, E. G., *Student Guidance Techniques*, p. 226, McGraw-Hill Book Company, Inc., New York, 1938.

exceed the median score of the general population, while only 27 per cent of policemen exceed this score.

CLERICAL APTITUDE

Clerical aptitude is not a unitary or primary aptitude but a category that includes a wide variety of jobs. Filing, sorting, bookkeeping, computing, cashiering, are some of the activities included. Most of these, however, depend on or involve a perceptual factor which may be defined as the ability to pick out detail quickly even when it is buried in irrelevant material. This factor is measured by checking differences in the spelling of paired names, differences in paired numbers, canceling out certain letters (or numbers) in lists of letters (or numbers), checking errors in simple arithmetical computations, simple filing or classifying of various materials, following directions, copying, etc.

The Minnesota Vocational Test for Clerical Workers consists entirely of checking differences in paired names and paired numbers. The National Institute of Industrial Psychology Clerical Test (American Revision) has seven parts—oral instructions, classification, aithmetical computation (adding, subtracting, multiplying, dividing), copying, checking, filing (numbers and names), and simple problems. Thurstone's Examination in Clerical Work consists of eight parts—checking errors in simple arithmetic, checking errors in spelling, crossing out certain letters in a list of 300 letters, translating letters into numbers according to a given code, filing names alphabetically under cities as given, checking as per directions, solving simple arithmetic problems, and pairing proverbs according to meaning. Other clerical tests follow the same general pattern as those just described.

Numerous studies have been made of the value of clerical tests in various occupations. Hay and Blakemore[12] administered the Minnesota Vocational Test for Clerical Workers to 229 applicants for clerical positions who had no previous clerical experience and to 241 applicants who had had from 1 to 20 years of previous clerical experience. On the numbers-checking part of the test there was a difference of 7.5 points in favor of the experienced group, and on the names checking there was a difference of 8.0 points in favor of the experienced group. The critical

[12] Hay, E. N., and Blakemore, A. M., The Relation between Experience and Scores on the Minnesota Vocational Test for Clerical Workers, *J. Appl. Psychol.*, 1943, 27, 311–315.

ratios of the differences were 3.4 in both cases. They also found that these differences were not due to intelligence, age, or academic training.

Davidson[13] made a very elaborate study of the value of a number of tests for selecting clerical workers who will succeed on the job and earn promotion. He found that there were low correlations between test scores and supervisors' ratings (see Table 3–7). However, when he correlated the scores with "promotability," or the "job level attained after five years or more of service," he found higher correlations for four of the tests and lower correlations for both parts of the Minnesota test. (see Table 3–8). He then selected the best parts of three of the tests and got still higher correlations. The Opposites and Number Series of the Bureau test correlated .82; the Spelling, Proverbs, and Arithmetic parts of the Thurstone test correlated .74; and the Spelling, Proverbs, Arithmetic, and Classification parts of the Modified Thurstone correlated .79. These were considered to be satisfactory for predicting promotability.[14]

TABLE 3–7. TEST SCORES AND SUPERVISORS' RATINGS

Test	N	r	SE_r
Bureau Test VI.	94	.41	.09
O'Rourke Senior.	82	.40	.09
Thurstone.	94	44	.08
Modified Thurstone.	94	.37	.09
Minnesota Clerical:			
Numbers.	94	.27	.10
Names.	94	.29	.09

TABLE 3–8. TEST SCORES AND PROMOTABILITY

Test	N	r	SE_r
Bureau Test VI.	49	.75	.06
O'Rourke Senior.	49	.77	.06
Thurstone.	49	.71	.07
Modified Thurstone.	49	.65	.08
Minnesota Clerical:			
Numbers.	49	.07	.14
Names.	49	.34	.13

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[13] Davidson, C. M., Analysis of Clerical Tests, *Person. J.*, 1937, 16, 95–97.

[14] The low correlations between the tests and supervisors' ratings is probably due to the inaccuracy of the latter. Too often tests are validated against a criterion that is less valid than the tests themselves. The criterion should be of known and generally accepted validity.

Aptitude Combinations

Some of the professions have developed tests which have been used with varied success to select likely candidates for specialization in those fields. Usually the tests are batteries, sometimes developed for that particular use but more often they are careful selections of published tests which measure the specific aptitude involved. Representative sampling of experience with both types of tests is briefly reviewed in the following pages.

Medical Aptitude. Perhaps no other profession has used psychological tests so extensively and so successfully as the medical profession. Under the leadership of Dr. F. A. Moss, a Committee on Aptitude Tests for Medical Schools of the Association of American Medical Colleges began in 1930 to administer a test to candidates for admission to medical schools. It consists of nine subtests—Scientific Vocabulary, Visual Memory, Memory for Descriptive Material, Premedical Information, Learning and Retention of Material, Understanding of Difficult Printed Material, Ability to Follow Directions, Logical Reasoning, and Spelling of Scientific Words—which are revised each year. The success of this test in selecting successful medical-school students is illustrated in Fig. 3–3.[15] Few medical schools will accept a candidate who makes a low score in this test.

Nursing Aptitude. Following the pattern of the medical profession many hospitals are now using tests to choose their student nurses. Douglass and Merrill[16] found that the Moss Nursing Aptitude Test and high school grade percentile rank correlated .75 with success in a school of nursing. This is unusually high and the authors warn that the same combination may not have such results at other institutions. However, Sartain[17] found that high school grades and the Potts-Bennett Tests for Nursing Aptitude correlated .70 with nursing school grades, and the Potts-Bennett Test alone correlated .67. Other investigations indicate that personality tests, however, are of no value in choosing student nurses.

Engineering Aptitude. As early as 1931, Cleeton[18] published a test

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[15] From Hunt, Thelma, Psychology in Medicine in Gray, J. S., *Psychology in Use*, p. 420, American Book Company, New York, 1951.

[16] Douglass, H. R., and Merrill, R. A., Prediction of Success in the School of Nursing, *Univ. Minn. Stud. Predict. Scholast. Achievmt.* 1942, **2**, 17–31.

[17] Sartain, A. Q., Predicting Success in a School of Nursing, *J. Appl. Psychol.*, 1946, **30**, 234–240.

[18] Cleeton, G. U., *The Carnegie Mental Ability Tests*, Houghton Mifflin Company, Boston, 1931.

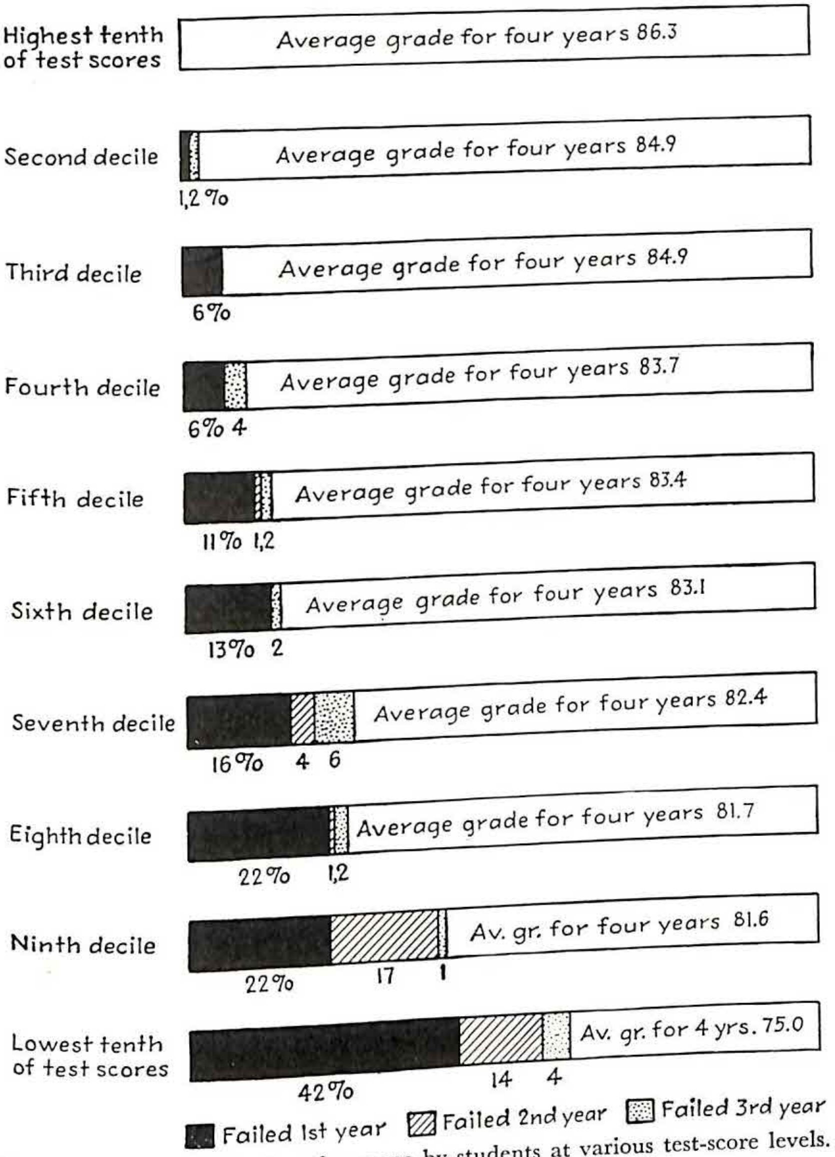

FIG. 3–3. Medical-school performance by students at various test-score levels.

predominantly for selecting students for schools of engineering. Three of the eight subtests measured mathematical ability. Correlations between the test and scholastic grades ranged from .50 to .70. Moore and his associates[19] have published a test for selecting engineering students which is composed of six subtests as follows: Mathematics, Formulation, Physical Science Comprehension, Arithmetic Reasoning, Verbal Comprehension, and Mechanical Comprehension. It correlates with grades in various school subjects as follows: mathematics .59; chemistry, 56; physics .72; manufacturing processes .38; and drafting .35.

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[19] Moore, B. V., Lapp, C. J., Griffin, C. H., Engineering and Physical Science Aptitude Test, The Psychological Corporation, 1943.

Sales Aptitude. The ability to sell seems to depend on so many different factors that a poor salesman in one situation may become a superior salesman in another. The nature of the goods sold and the general nature of the customers are important factors. Certainly there is little in common between the tobacco salesman whose customers are local tavern keepers and the air-brake salesman who calls only on executives of large corporations. Where psychological tests have been used with any success in selecting salesmen, they have been preceded by a careful job analysis and then selected to measure those human traits known to be important. Consequently, tests that are valuable in selecting salesmen in one situation may be useless in another. This does not justify the refusal, however, to discover what tests are useful in selecting salesmen for a specific situation. The employment manager of a department store once explained to the writer that he could tell by the way a girl walked whether or not she would make a good saleswoman. He further explained that he always gave her the courtesy of an interview anyhow.

Much research has been done in the selection of life-insurance salesmen. Kurtz[20] of the Life Insurance Sales Research Bureau found that weighted personal-data items (he calls this a "prediction scale") and a test of personality characteristics gave an aptitude index which was indicative of success in selling life insurance. Those who rated "excellent" on the aptitude index sold 206 per cent of the "average for all groups combined" during the first year; those who rated "very good" sold 137 per cent; those who rated "good" sold 78 per cent; those who rated "fair" sold 39 per cent; and those who rated "poor" sold 41 per cent.

Ordinary personality test scores seem to have but little predictive value in selling. Hampton[21] found correlations of .16 and less between the traits measured by the Bernreuter Personality Inventory and success in retail grocery-store selling. This is substantiated by other studies and with other personality tests.

Teaching Aptitude. Up-to-date teacher-training institutions usually accept students on the basis of superior intelligence, interest in teaching, and stable personality. The measurement of intelligence and interest has already been discussed in this chapter. Personality is more difficult to measure. In fact, it is even difficult to define. Psychologists usually define personality as "the sum total of those personal traits which establish one's social status" or affect other people. It is composed of habits, physical characteristics, manners of dress and speaking, knowledge and interest in people and things, attitudes, etc. It is everything and anything about an individual that may cause another to form an opinion of him. Obviously, such a combination of factors is difficult to measure. Personality tests are usually either trouble inventories or techniques of trait evaluation, not unlike the merit-rating procedures used in industry. The reliability of both procedures is so low that metrical scores are of doubtful value.

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[20] Kurtz, A. K., Recent Research in the Selection of Life Insurance Salesmen, *J. Appl. Psychol.*, 1941, 25, 11–17.

[21] Hampton, P., A Comparative Study of Certain Personality Traits and Success in Retail Selling, *J. Appl. Psychol.*, 1941, 25, 431–446.

Barr[22] summarizes a number of studies of the value of tests for predicting teaching success. While few single measures possess high validity, a composite of 14 measures gives a multiple correlation of .85. Rostker[23] found in his analysis of factors affecting pupil achievement that, while intelligence is the main factor in teaching efficiency, the personality of the teacher is unimportant. This peculiar conclusion is not substantiated by other studies.

Law Aptitude. While law schools do not use psychological tests as extensively as medical schools in choosing their entrants, the practice is fast becoming a custom. The great percentage of failures in the freshman year is evidence that law school entrants are not properly chosen. Those schools that use tests along with other factors in selecting their students have been able to reduce the failures in the first year.

More than 20 years ago Stoddard and Ferson[24] developed a Law Aptitude Examination which correlated .54 with grades made in the first year of law school. They found that 82.4 per cent of those who scored in the highest fifth on the test succeeded in law school, while only 61.2 per cent of those who scored in the lowest fifth succeeded. This test measures verbal memory, reading comprehension, reasoning, and general information. More recently Adams[25] used a revision of this test, now called the

[22] Barr, A. S., The Measurement and Prediction of Teaching Efficiency, *Rev. Educ. Res.*, 1946, **16**, 203–208.

[23] Rostker, L. E., The Measurement of Teaching Ability, *J. Exp. Educ.*, 1945, **14**, 6–51.

[24] Stoddard, G. D. and Ferson, M. L., Law Aptitude Examination—Preliminary Report, *Amer. Law. Rev.*, 1927, **6**, 78–81.

[25] Adams, W. M., Predictions of Scholastic Success in Colleges of Law, *Educ. and Psychol. Meas.*, 1944, **4**, 13–19.

Iowa Legal Aptitude Test, and found a multiple correlation of .76 between test scores and first-year law school grades.

SUMMARY

This chapter has briefly outlined scientific methods which may be used to help place workmen on jobs appropriate for their qualifications. Typical studies indicating the worth of these methods were noted. It is no longer necessary to hire men and place them on jobs without regard to their qualifications, nor even to leave this responsibility to the judgment of some employment manager who claims to be able to discern human fitness from the naïve observation of physical characteristics. However, methods of job analysis and worker-ability analysis must be used only by those properly trained and qualified for their use. This and the preceding chapters are intended merely to indicate the general nature of such methods. In no sense are they sufficiently detailed to be used as a handbook in lieu of more adequate description and explanation.

Progress in this field is very rapid, especially in methods of analyzing worker ability. Before these words appear in print, new tests and new devices no doubt will have been developed to measure abilities more accurately and adequately. The scientific personnel psychologist must be constantly alert for new developments in his field. One less well-trained and less-specialized has neither the facilities for keeping up with new psychological developments nor the ability to evaluate their worth.

RECOMMENDED READINGS

BINGHAM, W. V.: *Aptitudes and Aptitude Testing,* Harper & Brothers, New York, 1937.

BURTT, H. E.: *Principles of Employment Psychology,* Harper & Brothers, New York 1942.

DORCUS, R. M., and JONES, M. H.: *Handbook of Employee Selection,* McGraw-Hill Book Company, Inc., New York, 1950.

GRAY, J. S.: *Psychology in Human Affairs,* Chaps. 5, 13, McGraw-Hill Book Company, Inc., New York, 1947.

GREENE, E. B.: *Measurement of Human Behavior,* The Odyssey Press, New York, 1941.

MOORE, H.: *Psychology for Business and Industry,* Chaps. 1–8, McGraw-Hill Book Company, Inc., New York, 1942.

SCOTT, W. D., CLOTHIER, R. C., MATHEWSON, S. B., and SPRIEGEL W. R.: *Personnel Management,* Chaps. 8–22, McGraw-Hill Book Company, Inc., New York, 1941.

SHARTLE, C. L.: *Occupational Information,* Prentice-Hall, Inc., New York, 1946.

TIFFIN, J.: *Industrial Psychology,* Chaps. 1–6, Prentice-Hall, Inc., New York, 1947.

VITELES, M. S.: *Industrial Psychology,* Chaps. 8–15, W. W. Norton & Company, New York, 1932.

Chapter 4

JOB TRAINING

- Psychological Principles of Learning
  - Principle of Practice or Drill
  - Principle of Comprehension
  - Principle of Knowledge of Progress
- Patterns of Training
  - Training Workers
    - On-the-job Training
    - Vestibule Training
    - Apprenticeship Training
  - Training Supervisors
    - Basic Principles of Human Relations
    - Specific Problems in Human Relations
    - Selecting Supervisors
  - Training Executives
    - Understudy
    - Company Conferences, Lectures, Projects, etc.
    - Affiliated Training
  - Training Specialists
    - Salesmen
      - Knowledge of Product
      - Analysis of Customer Problems
      - Personality Development
    - Engineers
    - White-collar Employees
- Summary

It is very important to analyze jobs and then to analyze workmen and place them on the jobs which are most appropriate for their aptitudes. While efficiency cannot be attained without this, a further step is also important. Those workmen must be trained properly. Appropriate aptitude will not function efficiently on a job unless it is appropriately trained. Even workmen with long years of experience can be trained to increase their efficiency. Greenly[1] found that a program of training reduced the average time necessary to change shear knives in a steel plant from 29 to 18 minutes (see Fig. 4–1). He estimated that this saved the company involved almost $21,000 per year.

There are many different types of industrial training—job training, apprenticeship training, supervisory training, executive training, and special training of various sorts. In a large company, the training department may be a very broad and complicated organization. A graph of such an organization is shown in Fig. 4–2.

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[1] Greenly, R. J., Job Training, *N.A.M. Labor Relations Bulletin*, No. 35, 1941, pp. 5–8.

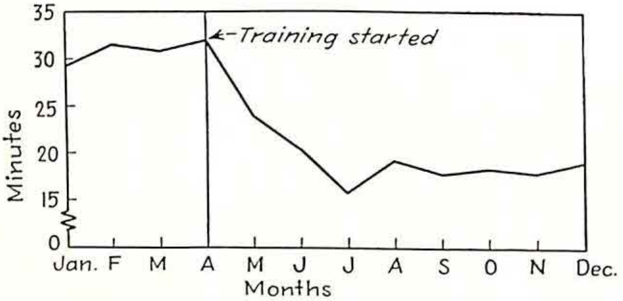

FIG. 4–1. Effects of a training program on time for changing shear knives.

However, all training involves teaching and learning, and the basic principles are the same. This chapter will first concern the principles of training and then the types of training.

PSYCHOLOGICAL PRINCIPLES OF LEARNING

Learning has become the *sine qua non* of psychology. The philosophers were concerned with the nature of the mind but psychologists are interested in the more practical problems of learning. They want to know how we learn and what conditions facilitate its occurrence. As would be expected, most of the research in this field has been done by the educational psychologists. They have studied learning curves, learning plateaus, rate of forgetting, conditions affecting learning, appraisal of learning, physiological changes in learning, etc. Learning as it takes place in the classroom has been more thoroughly studied than learning as it takes place in the factory or in the business establishment. However, human learning is basically the same regardless of where it takes place or why it takes place. Learning to read is not basically different from learning to operate a turret lathe.

PRINCIPLE OF PRACTICE OR DRILL

The boy who hangs his clothes on a hickory limb and does not go near the water will never learn to swim. The only way he can learn to swim is to practice swimming—in water. It is impossible to learn any behavior without performing it. Only by doing can one learn to do—and whatever is done will be learned, wrong behavior as well as right.

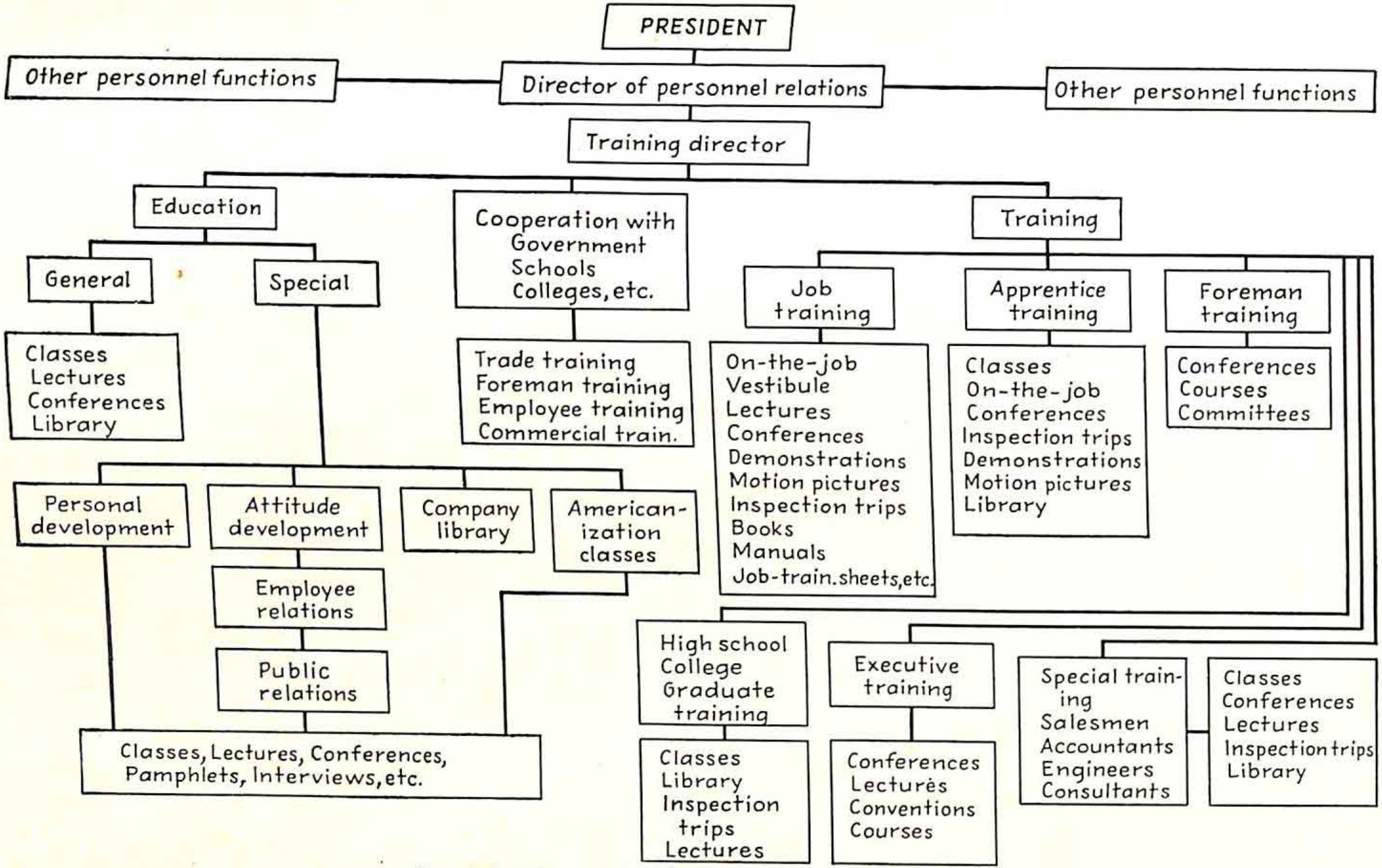
PRESIDENT
Other personnel functions
Director of personnel relations
Other personnel functions
Training director
Education
Cooperation with Government Schools Colleges, etc.
Training
General
Special
Classes Lectures Conferences Library
Trade training Foreman training Employee training Commercial train.
Job training
Apprentice training
Foreman training
On-the-job Vestibule Lectures Conferences Demonstrations Motion pictures Inspection trips Books Manuals Job-train.sheets, etc.
Classes On-the-job Conferences Inspection trips Demonstrations Motion pictures Library
Conferences Courses Committees
Personal development
Attitude development
Company library
American-ization classes
Employee relations
Public relations
Classes, Lectures, Conferences, Pamphlets, Interviews, etc.
High school College Graduate training
Executive training
Special training Salesmen Accountants Engineers Consultants
Classes Conferences Lectures Inspection trips Library
Classes Library Inspection trips Lectures
Conferences Lectures Conventions Courses

FIG. 4–2. The training department of a large company.

Applied to job training, this means that the only way to learn a job is to perform it. A man can learn to operate a machine only by operating that machine. A girl can learn to use a typewriter only by using a typewriter. The basic principle of learning is practice or drill.

Almost any training experience illustrates the relation between the amount of learning and the learner's aptitude. Figure 4–3 shows the rate of learning the radiotelegraphic code by four groups of soldiers classified on the basis of their scores on the army Radiotelegraph Operator Aptitude Tests.[2] Note that those who rated higher on the tests were learning more rapidly than those who rated lower at every 2-week level during the entire course of training. Those with greater aptitude profited more from training than did those with less aptitude.

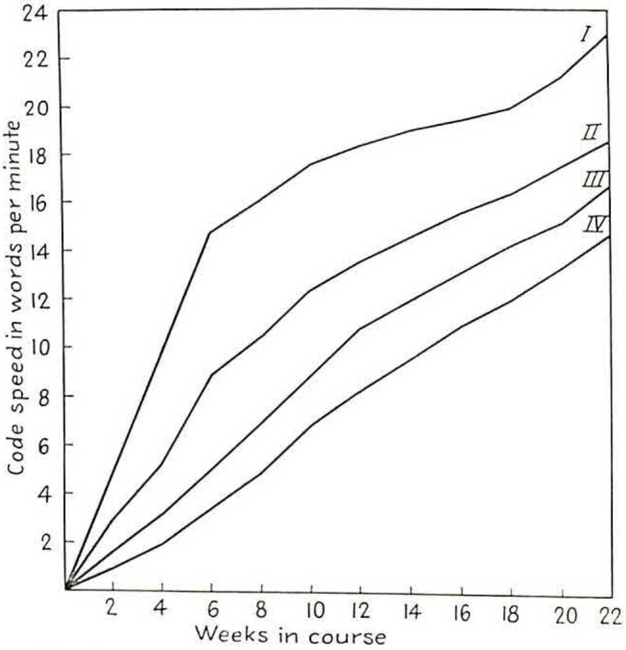

FIG. 4–3. Radiotelegraphic code learning by soldiers at four levels of aptitude.

Table 4–1 gives the learning rate of five "power-press-straightener" operators for the first 10 half days of a training period. Aside from learning how to operate a power press, it was necessary to learn how to position forgings so as to bend them to proper shapes with small tolerances allowed. The work was not "straightening" as suggested by the

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[2] Modified from Boring, E. G., *Psychology for the Armed Services*, p. 244, Infantry Journal, Washington, D.C., 1945.

TABLE 4–1. NUMBER OF FORGINGS STRAIGHTENED DURING FIRST 10 HALF DAYS OF A TRAINING PERIOD BY FIVE TRAINEES

Half days	Trainees				
	A	B	C	D	E
1	5	3	3	5	4
2	6	8	6	7	5
3	10	11	9	8	7
4	12	12	8	12	6
5	11	11	11	14	9
6	13	16	13	15	11
7	13	18	14	17	10
8	16	17	16	19	13
9	15	19	17	21	14
10	15	18	18	21	14

job title, but "bending to specifications." The data in the table do not include the forgings which were rejected by the inspectors to be "restraightened."

Lawshe[3] compared a group of 48 new employees who were in a training program with a group of 67 new employees who were not. At the end of 4 weeks, 32 per cent of the training group and 16 per cent of the control group met production standards. At the end of 8 weeks, 46 per cent of the training group and 37 per cent of the control group met the standard production quotas.

The performance of a job is often so complicated that the average workman cannot learn all the acts composing it without making errors. This results in learning the errors as well as, or often instead of, the correct acts (in accordance with the above principle of learning that whatever acts are performed are learned). It is then necessary, later on, to unlearn the errors and in their stead to learn the correct acts in correct sequence. The total job learning time is therefore delayed beyond what it would have been if the errors had not been learned.

To avoid this situation, it is often better to break the job down into units which can be learned independently. These are called *training units* and are illustrated in Table 4–2. Each step in the entire job is practiced until it can be performed without error before the next step is attempted. If the step is complicated, it is well to break it down into

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[3] Lawshe, C. H., Eight Ways to Check the Value of a Training Program, *Fact. Mgmt. and Maint.*, 1945, 117–120.

TABLE 4–2. JOB BREAKDOWN INTO TRAINING UNITS
Job—Mill dovetail

Steps or units of performance	Key points
1. Select cutter	Small—minimize chatter
2. Select holder parallels	Narrow—yet to give good hold
3. Place piece in vise	Check with tissue
4. Rough-cut	Start by hand—1 in.—check for finished stock and location
5. Trial finish-cut	Check—make correction
6. Finish-cut	Finish without stopping
7. Remove from vise	
8. File burrs	
9. Check	

specific acts in their necessary sequence. Then, the learner performs each act in order and there is a minimum of opportunity for error. See Table 4–3 for a training-unit analysis.[4]

Other factors (as noted on the following pages) are important in learning, but this principle of practice is fundamental. Learning cannot take place without it. The behavior patterns of a machine can be changed by rebuilding it. Practice or operation have but little effect on its structure. Not so with the behavior patterns of a workman. They can be changed only by performing the new behavior slowly and accurately over and over again until the desired patterns grow into his neural and muscular structure. Only then can he attain speed of performance. Learning is the effect of behavior and can take place in no other way.

TABLE 4–3. TRAINING UNIT BREAKDOWN INTO OPERATION SEQUENCE
Job—Mill dovetail. Unit—Rough-cut (No. 4)

Steps in operation	Key points
1. Run up table by hand	Slow when near cutter
2. Feed 1 in. by hand	Never run table back while cutters are in use
3. Stop machine and run table back	Location and finish
4. Check cut	
5. Set feed	
6. Start machine	
7. Finish-cut	
8. Check	

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[4] Tables 4–2 and 4–3 are modified from Seashore, S. E., Training and Merit Rating, in Gray, J. S., *Psychology in Human Affairs*, p. 461, McGraw-Hill Book Company, Inc., New York, 1946.

PRINCIPLE OF COMPREHENSION

While practice or drill is more fundamental, it is preceded in good training practice by a comprehension of what is to be learned. Learning will take place without understanding the nature of the material learned, but it will be slow and inaccurate. Meaningful behavior is learned more rapidly and easily than meaningless behavior. Even animals will learn more quickly if they understand the behavior they are learning to perform.[5] The first step in good job training is to explain to the workman what he is supposed to learn and why he should learn it. This is so important that good job instruction requires the workman to explain back again to his instructor what, why, how, when, and where he is to learn. Inadequate information and misunderstandings can then be corrected. In other words, the workman should have an accurate mental picture of what he is to learn, why he is to learn, how he is to learn, when he is to learn, and where he is to learn, before he begins the learning practice.

The nature of this prepractice comprehension will, of course, depend on the nature of what is to be learned. If the job is one of high skill level, like metal patternmaker (5-17.010), it may take years of preliminary experience on jobs of lower level skill, like pattern gater (6-82.930), to become able to acquire the necessary comprehension. Some jobs, like heat-treater (4-81.010), require basic information, like physics and chemistry, as well as preliminary experience before comprehension training can begin. Other jobs of semiskilled level require only a few minutes of explanation and demonstration for adequate comprehension to begin practice performance of the behavior to be learned.

A few simple directions are applicable to the problem of getting workmen to comprehend the nature of work on the semiskilled level:

1. Tell the workman in simple language what he is to do, why he is to do it, how he is to do it, when he is to do it, where he is to do it, and who is to supervise him. Be sure to use simple language. (Remember that the average workman's vocabulary is not over 3,500 words.) Explain the meaning of all necessary unusual terms. Go slow. Give him time to understand. Do not get him excited and lost as you proceed.

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[5] Numerous experiments with both humans and animals illustrate this principle. Ebbinghaus found that meaningful words were learned more quickly than meaningless words. Thorndike found that cats learned slowly in a puzzle box which they could not comprehend, while Koehler found that chimpanzees learned rapidly when the behavior was simple enough for them to comprehend its meaning.

Encourage him to ask questions. Repeat important or complicated explanations. Be careful not to underestimate or overestimate his progress in comprehension.

2. When it appears that the workman understands the work to be performed, he should be asked to explain it back to the instructor. Ask him questions as though you were the learner and he the instructor. This will reveal gaps and errors in his comprehension and enable you to give what further explanation is necessary. Do not rush this step. Continue your explanation until he is able to explain the procedure back to you without error.

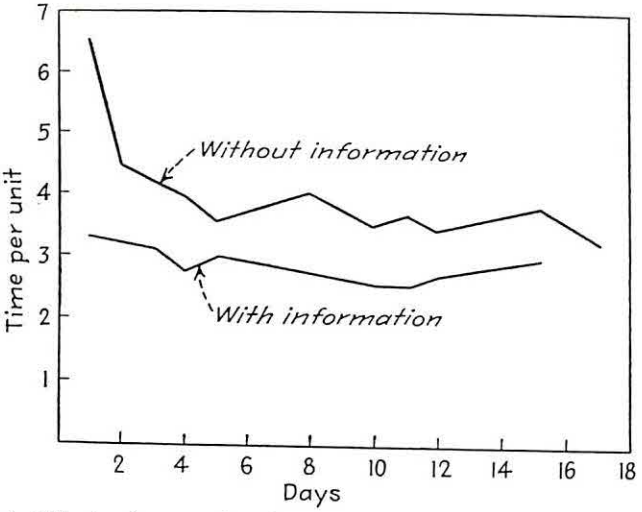

FIG. 4–4. Effects of comprehension on learning to assemble light sockets.

3. A further step in comprehension is to demonstrate the work to be performed. This may come during the explanation step described above or after the workman has comprehended the explanation, depending on the nature of the job. This is not to teach him to perform the job, but only to show him how the job is performed. Proceed slowly and again explain the function of each step. Emphasize important points and explain why they are important. Point out safety factors and explain the dangers of carelessness. Repeat the demonstration several times and ask the workman questions to be sure that he has learned what he is supposed to have learned.

Numerous studies illustrate the importance of comprehension in learning. Cox[6] reports a comparative study of the rate of learning for two groups of electric-lamp-socket assemblers—one group having full understanding of the nature of the work and the other without any preliminary information. As indicated in Fig. 4–4, the group having information was superior to the one without information throughout the 17 days of comparison.

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[6] Cox, J. W., *Manual Skill*, p. 111, Cambridge University Press, London, 1934.

Twitmyer[7] compares two groups of students in learning a stylus maze while blindfolded. One group was entirely unfamiliar with the maze before learning, while the other had observed it carefully. The second group learned about the same in five trials as the first did in fifteen.

PRINCIPLE OF KNOWLEDGE OF PROGRESS

Psychological experiments have repeatedly demonstrated that practice with no knowledge of learning progress does not result in learning. The learner must know how well he is doing in each practice or there is but little improvement. Numerous studies substantiate this conclusion. Elwell and Grindley[8] used a two-hand coordination apparatus which could be operated both with and without knowledge of the success of operation. Ten subjects were given 200 practices with knowledge of their learning progress, and then 100 practices without knowledge of their progress. The results are shown in Fig. 4–5. Note the rapid loss of learning in the latter part of the experiment. Thorndike[9] blindfolded subjects

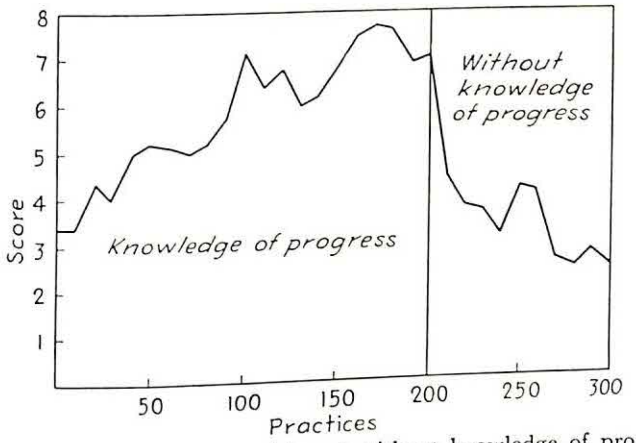

FIG. 4–5. Learning practice with and without knowledge of progress.

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[7] Twitmyer, E. M., Visual Guidance in Motor Learning, *Amer. J. Psychol.*, 1931, 43, 165–187.

[8] Elwell, J. L., and Grindley, G. C., The Effects of Knowledge of Results on Learning and Performance, *Brit. J. Psychol.*, 1938, 29, 39–54.

[9] Thorndike, E. L., *Human Learning*, p. 11, Appleton-Century-Crofts, Inc., New York, 1931.

and had them practice drawing 4-in. lines without information concerning accuracy. He found that drawing 3,000 lines resulted in no learning. For one subject, the median length of the lines drawn was 4.96 in. for the first day and 5.23 in. for the last day of practice.

It must be emphasized that efficient training depends on these three principles functioning together. The omission of any one will handicap training progress. The trainee must practice performing his job, he must understand what he is doing, and he must know how fast he is learning. Only then can his learning be at optimum speed. There are still other factors which affect progress in learning, although to a lesser degree. First, the trainee must be strongly motivated; that is, he must want to learn the job. Other things being equal, the stronger his motivation the greater his learning. Second, the trainee must enjoy his training experience. If he dislikes the training practice, he will learn slowly. Every effort should be made to make training an enjoyable experience. Third, the trainee should be as free as possible from distractions during training. The most rapid learning occurs when there are few distractions. Fourth, training practice should be distributed over enough time to allow it to "sink in." Intermittent practice is usually better for learning than continuous practice. These factors, however, are all secondary to the importance of the principal of practice, the principle of comprehension, and the principle of knowledge of progress. With these principles of learning in mind, let us now consider some of the common patterns of training men for work.

PATTERNS OF TRAINING

Industrial training varies, of course, with the nature of the work, the location of the training, the individuals being trained, the qualifications of the trainers, the tools and materials being used, the quality level of the finished product, the time and money available for training, and various other conditions which are peculiar to specific training situations. The patterns of training must always be "tailor-made" to fit the characteristics and needs of a specific situation. This means that the training situation must be carefully analyzed and the training program carefully adapted to the needs thereof. This requires the major attention of individuals of superior ability and the supervisory attention of the policy-making brains of the organization concerned.

Unfortunately, however, the responsibility for developing the training program is too often delegated to someone who is inadequately prepared, either by nature or by education, for such an important undertaking. As a result, industrial training is now at the armchair stage where methods used are evaluated almost entirely by the opinions of those in charge.

This indictment is justified by a study by Dorcus and Lokin,[10] who found that a representative sampling of personnel men were inadequately prepared for personnel work. Less than half of them had had two courses of formal training and one-fourth had had no special training at all. The courses considered as special training and the per cent of personnel men having taken each are given in Table 4–4. Ayers[11] checked the articles published in two personnel journals and found that less than 10 per cent of them had any known justification in fact. He says: "Making an analysis of all articles appearing in the *Personnel Journal* and the *Personnel* for the past five years, it was found that less than ten per cent of those published had any basis in measured results." Obviously, this explains why industry knows so little about the effectiveness of its training programs.

TABLE 4–4. PER CENT OF PERSONNEL MEN HAVING TAKEN VARIOUS SPECIAL COURSES OF TRAINING

Principles of economics	70
Principles of psychology	63
Tests and measurements	22
Industrial or business psychology	24
Elementary accounting	48
Advanced accounting	19
Business organization	39
Industrial management	37
Statistics	36
Public administration	21
Vocational education	10

TRAINING WORKERS

Job training has always taken place in some manner, but in more recent years it has become formalized and patterned. A typical procedure of training a new workman is as follows:

1. Introductory (may occur before employment)
    a. History of company—nature of products, size and importance of company, honors and commendations received

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[10] Dorcus, R. M., and Lokin, R. D., Survey of personnel workers, *Person. J.*, 1943, 21, 251–254.

[11] Ayers, A. W., Research Needed in Personnel Administration, *Person. J.* 1947, 26, 127–129.

  - *b.* Company services and wages—benefits, insurance, vacations, retirement, policies of promotion
  - *c.* Trip through plant
  - *d.* Safety rules
2. Job performance
  - *a.* Observation of job
  - *b.* Information about job
  - *c.* Try job (perform job operation)
  - *d.* Follow up or check performance

The values of good training are great, both to the company and to the employee. Company values may be listed as follows:

1. Production is increased.
2. Waste and spoilage are reduced.
3. Unit costs are reduced.
4. Less supervision is necessary.
5. Labor turnover is reduced.
6. Labor tension is reduced (workers are better satisfied).

Employee values are:

1. Earnings increase.
2. Fatigue and effort increase.
3. Accidents decrease.
4. Happiness increases.

Job training should be preceded by job analysis to determine exactly what the job is and by motion analysis to determine if there is any better way of doing the job. The former was discussed in the last chapter in this book, and the latter is the subject of the next chapter.

An adequate job training program must be thorough and include every useful phase of job performance. It must teach a man all he needs to know in order to become a superior workman. Prosser and Van Wyck[12] have analyzed worker habits into six groups. These are as follows:

1. *Arrangement and care of tools, equipment, and supplies.* A workman must learn what to do with tools, equipment, and supplies while they are not in use as well as while they are in use. The proper location of a tool when not in use may make it so accessible that minutes are saved each day and hours each week. It is not unusual for a workman

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[12] Prosser, C. A., and Van Wyck, P. S., *How to Train Shop Workers,* p. 10, *American Technical Society,* Chicago, 1941.

to double his production by improving the pattern of his job operation and the relocation of his tools, equipment, and supplies. Such analysis and reorganization, however, is the function of the industrial engineer and will be discussed in the next chapter.

2. *Safety precautions.* A trainee must learn the danger areas of a job, the way accidents may and do occur, the safeguards and precautions that should be observed, the procedure in case of accident, the location and use of first-aid facilities, and the general importance of safety habits. (Safety is discussed more fully in Chap. 9 of this book.)

3. *The use of power equipment.* A workman must learn that power equipment possesses neither reflex action nor inhibitions but will start, function, and stop only as he operates the controls. He must learn how to check it for service, how to care for it, how to control it, and how to avoid accidents with it. Power equipment is inanimate and the workman must supply the brains for its operation.

4. *Tools and equipment setup.* In some situations a "setup man" is provided so that the machine operator does not need to be concerned with this function. In most cases, however, the operator must be able to prepare his machine for operation. He must change his bits, or grinders, or dies, or templates, or whatnots. He must oil and adjust his machine, sharpen his tools, position his supplies, in short, prepare for the machine's operation.

5. *Skills for job performance.* Skills vary with each operation but their acquisition, regardless of nature, depends on the functioning of the basic principes of learning as discussed earlier in this chapter.

6. *Accuracy checks.* A workman must learn how to diagnose his lack of accuracy and correct it. He is not yet trained until he is able to distinguish between work of good quality and work of poor quality. He must learn to inspect his own work, to eliminate the causes of error, and to establish habits which result in a product of standard quality.

On-the-job Training. The most common type of worker training is "on the job," or more accurately, "on the position." A foreman, or a supervisor, or an experienced workman, will conduct the trainee to the location of the job (position), explain what is done, demonstrate the operation, supervise the initial efforts of the trainee, then check him occasionally and, if necessary, give additional assistance. In most cases the procedure is unplanned, without system, and is conducted by those without special qualifications for instruction. In 1940, the National Industrial Conference Board made a survey of the extent and nature of training in 2,700 companies in the United States.[13] The Board found that only 284 of these companies had planned training programs for production workers. Of these, 168 had centralized training and a director of training. This picture changed during the war when practically all companies had planned job training programs. The extent to which these programs have been retained in postwar operations is unknown, but certainly planned job training is more prevalent in industry today than it was in 1940.

In a properly planned on-the-job training program, the job is broken down into instructional units, as illustrated in Table 4–2. Each unit is then broken down into operation steps, as illustrated in Table 4–3. This is called an "instruction sheet" and is the textbook for that unit of instruction.

Perhaps one of the best job instruction plans ever devised was the "JIT" program developed by the Training within Industry branch of the War Manpower Commission in 1942. After Pearl Harbor, industry needed new recruits by the millions. Both men and women had to be quickly trained to perform jobs of skilled and semiskilled levels. But before men could be trained, instructors had to be trained. The Job Instructor Training Program was first given at a few training centers to carefully selected men from key industries. These "instructors" returned to their own industries and gave the course to other selected men who, in turn, gave it to still others. In all, thousands of supervisors and workmen took the course in how to train new workmen. The textbook for these JIT courses was a little card about 2 by 3 in. in size with the information on it as shown in Table 4–5. The course lasted only 10 hours, but during that time men learned how to instruct other men to perform a job. No other method of job training was ever used to train so many men in so short a time.

The importance of training instructors how to train men in job operation is illustrated in a study of Bavelas and reported by Maier.[14] He found that instructor training is reflected in the learning curves of his trainees. Figure 4–6 shows this close relationship. Curve 1 illustrates the instructor's effectiveness as a trainer before he himself had received any instructor training. Curve 2 illustrates his effectiveness after he had received preliminary instructor training. Curve 3 illustrates his effectiveness after his course in instructor training was completed. Obviously, job instructors should be trained how to instruct.

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[13] See *Studies in Personnel Policy*, No. 20.

[14] Maier, N. R. F., *Psychology in Industry*, p. 227, Houghton Mifflin Company, Boston, 1946.

The effectiveness of on-the-job training in comparison with other methods of worker training is not clear. Few studies have been made of training methods, in comparison with each other, where variables have been adequately controlled. On the other hand, there have been a number of studies of the relative effectiveness of a reformed training program in comparison with previous training methods. Lawshe[15] reports a study of the effects of a new training program on the production of diamond wire dies. The work was drilling small holes through diamond chips, used in making tungsten wire for vaccum tubes. After a training program was introduced production per man-hour increased approximately 40 per cent.

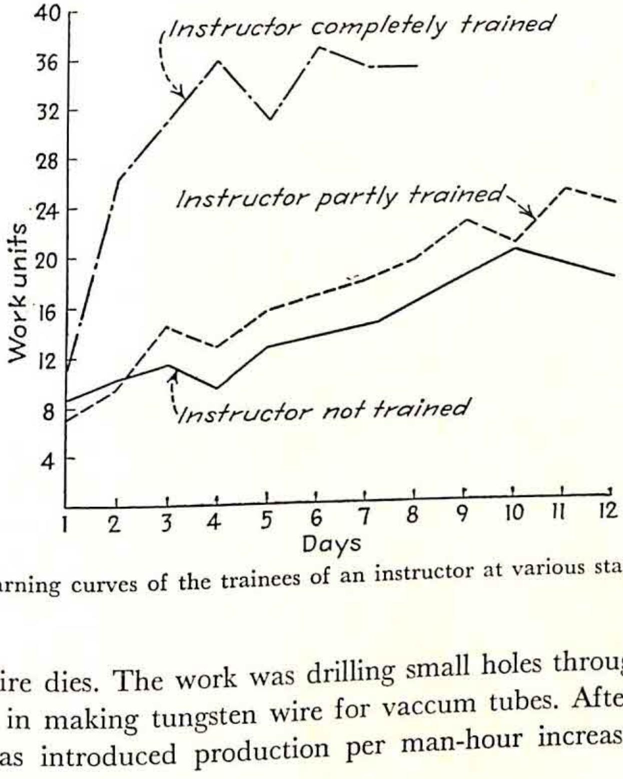

FIG. 4–6. Learning curves of the trainees of an instructor at various stages of his own training.

Vestibule Training. Some companies provide separate rooms or buildings for training new employees. These are called "vestibule schools" and usually provide a better learning situation than is possible in on-the-job training. There is less distraction, instructors have less interfering responsibilities, regular production is less impeded, and special

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[15] Lawshe, C. H., Training Operative Personnel, *J. Consult. Psychol.*, 1944, 8, 154–159.

TABLE 4–5. WAR MANPOWER COMMISSION JOB INSTRUCTOR CARD

How to Get Ready to Instruct *Have a time table—* How much skill do you expect him to have and how soon? *Break down the job—* List principle steps. Pick out the key points. *Have everything ready—* The right equipment, materials, and supplies. *Have the work place properly arranged—* Just as the worker will be expected to keep it.	Step III—*Try out performance—* Test him by having him perform the job. Have him TELL and SHOW you; have him explain key points. Ask questions and correct errors. Continue until you know that he knows. Step IV—*Follow up—* Put him on his own. Designate to whom he should go for help. Check frequently. Encourage questions. Get him to look for key points as he progresses. Taper off extra coaching and close follow-up.
How to Instruct Step I— *Prepare the worker—* Put him at ease. Find out what he already knows about the job. Get him interested in learning job. Place him in correct position. Step II—*Present the operation—* Tell, show, illustrate, and question carefully and patiently. Stress key points. Instruct clearly and completely, taking up one point at a time—but no more than he can master.	IF THE WORKER HASN'T LEARNED, THE INSTRUCTOR HASN'T TAUGHT *Job Instructor Training* War Manpower Commission Bureau of Training Training Within Industry KEEP THIS CARD HANDY

equipment conducive to the best training can be provided. Streetcar motormen usually receive preliminary vestibule training before they are taken out for on-the-job training. Because of the additional cost of providing special rooms, instructors, equipment, etc., vestibule training is usually found only in the larger companies. Westinghouse Electric, Western Electric, General Motors, Wright Aeronautical, Colt Fire Arms, Bausch and Lomb Optical, and others have long trained new workmen in vestibule schools.

There are a number of factors which determine the worth of vestibule training. These should be carefully evaluated before vestibule training is introduced.

1. Is adequate space available, near where the men will eventually work, which is not more valuable for some other use?

2. Are enough new employees being hired to justify the additional expenditure of money for space, equipment, training personnel, etc?

3. To what extent is the regular flow of production now hindered by the present training procedure.

4. To what extent can some other training plan (like night training in the local vocational schools as in the "Connecticut Plan") perform the same function at less cost?

Perhaps objective studies have been made of the comparative value of vestibule training and on-the-job training, but they are unknown to the author. Industrial personnel men have published their opinions of the comparative value of the two methods, but the justifying evidence has always been omitted.

Apprenticeship Training. Apprenticeship training is an organized program of training in which the trainees work at certain jobs for specified periods of time and take courses in related subjects in the company's own school or in cooperating high schools, trade schools, colleges, or institutes. The training lasts from 1 to 7 years and terminates, if satisfactorily completed, in the trainee's becoming a "journeyman" and being eligible for recognition as such by his trade union. It is the method of training most generally used in learning the various "trades." The trainee often signs an agreement or indenture with the company which states the duration of the training, the rate of pay, and often the weeks to be spent on each job. The apprenticeship training course of one company is outlined as follows:

Age: Not less than 18 nor over 20 years of age.

Education: Must be a graduate of high school and have passed the following courses (1 year of each):

Algebra
Geometry
Physics
Chemistry
Machine Shop

Physical: Must have better than average rating by company doctor in both health and physique.

Character: Must present evidence of character and moral traits satisfactory to the company.

Terms of apprenticeship: Four years or approximately 8,000 hours.

Probationary period: Student may be dropped any time during first 4 months if he is not considered qualified to continue.

Schedule: The following schedule is approximate and will vary with economic conditions and company needs:

Drill press	10 weeks
Engine lathe, turret lathe	18
Grinding	28
Milling	28
Tool grinding	6
Inspection	6
Foundry	8
Pattern shop	2
Heat-treat	8
Welding	6
Supply room	16
Machine repair	10
Assembly	20
Salvage	12
Miscellaneous	32
Total	200

Related instruction:

First year—Shop mathematics, mechanical drawing, shop practice.

Second year—Tool design, general mechanics, English (oral and written).

Third year—Machine design, pattern making, engineering, metallurgy, industrial chemistry.

Fourth year—Business management, industrial psychology, advanced shop mathematics, production methods.

Hours of work: Same as that in department to which assigned.

Compensation: Progressively increased each 6 months of the 4-year period. (Actual rates deleted.)

Supervision: Apprentices shall be under general supervision of director of training. While assigned to a department, he is under the foreman and supervisors, as is any other employee. In school, he is under the instructor of the course.

Awards: Upon completion of the 4 years' training, all apprentices will be given a cash award of $100 and a certificate of completion of apprenticeship in "applied manufacturing practice."

Other programs of apprenticeship requirements have been established by the various craft unions. In most cases, however, such programs have been the joint effort of the company and the union involved. Unfortunately, the apprenticeship system has been abused too often by both companies and unions for selfish gain. Companies use it to get work done at substandard rates of pay, and unions use it as a means of limiting the number of journeymen and thus creating a pseudo scarcity of trained workmen as a consequence. The trend now is toward national and state regulation of apprenticeship training. The National Recovery Administration in 1933 set up a coordinating program, national in scope, for apprenticeship training. More recently joint committees of company and union representatives have been established under the supervision of the Department of Labor to work out the formulation of standards, the number of trainees, the rates of pay during training, etc. Thus the oldest system of job training known to man seems to be in for a revival and expansion.

Now, which of the three methods of worker training just discussed—on-the-job training, vestibule training, apprenticeship training—is superior? Comparative studies have not been made. Where used, all three are justified by opinion. The author will not contribute further to the mass of unproved verbiage.

TRAINING SUPERVISORS[16]

The superintendent of a fabricating steel plant recently remarked to the author that his "headaches" were not problems of production but problems of supervision. What he meant was that his supervisors understood how to control their machines but they did not understand how to control their men. They could take care of the machine element with but little assistance but they could not take care of the human element. They were able to facilitate the function of machines but they often actually interfered with the function of men. Much of the superintendent's time was spent repairing damage to human feelings caused by his supervisors who did not know how to deal with their men.

The reason is obvious. Supervisors are usually elevated to their positions because they are good production men. They know how to control machines. This is fundamental. A supervisor could not function if he did not know how to process his material. But when he confronts the *personnel* factor in the process, he is often totally without experience and training. Unfortunately, he must supervise men as well as machines. It would be surprising if he did not make errors in controlling the human factor. While he is a master craftsman with material, he is a novice with personnel.

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[16] All types of supervision are included in this category. The foreman, the straw boss, the crew leader, the superintendent, the section boss, the gang chief, the section head, etc., are all included here as supervisors.

The remedy is not to choose psychologists as supervisors. Supervisors must know machines and production. That is fundamental. Rather, the remedy is to train supervisors, those master craftsmen, and prospective supervisors, how to control the *human factor* in production. It is easier and quicker to make a psychologist out of a supervisor than it is to make a master craftsman out of psychologist.

The best way to train supervisors—in fact, the worth of any method of training supervisors—is unknown. In general practice, however, supervisory training is either in a class where principles of psychology and human relations are studied, or in a class where practical problems of supervision are discussed. The former is likely to be called a "lecture" and the latter a "conference." Both may be conferences and both may be lectures, but the former is a study of basic principles and laws, while the latter is a study of these in specific application. They are comparable to a lecture course in chemistry and a conference on specific problems concerning the composition of synthetic-rubber gaskets.

Basic Principles of Human Relations. Regardless of the educational level of supervisors and prospective supervisors, there are some things about human psychology that they must know if they are to learn to supervise other people successfully. A course in practical, useful, understandable psychology is essential. It must be taught in such a way that the men comprehend it and use it. Perhaps sometime we will know what that way is. At the present time, it apparently depends on the teacher. Some teachers can lecture and get it across. Some can discuss and get it across. The method is unimportant if the student learns. (The teacher doesn't teach if the student doesn't learn—see Table 4–5.) Most supervisor training programs have a course along this line, although the word "psychology" is seldom used. "Human relations" is a more common title.

Other courses in human relations frequently included in a supervisor training program are: training problems, safety methods, leadership development, labor laws, grievance adjustments, work methods, ability testing, and mental health. In all of these, basic principles and facts are more important than specific local applications. The attempt is to give the supervisor an understanding of fundamental principles on which he can then base his decisions regarding specific situations.

Specific Problems in Human Relations. This part of supervisory training is usually in the form of conferences and round-table discussions

The objectives concern the course of action in specific situations. Basic principles are discussed, but only if and as they are applicable to the specific problem under consideration. On-the-job supervisors, and those who have had the basic courses mentioned above, profit more from these conferences than do prospective supervisors who are not acquainted with the basic principles.

The success of a conference meeting often depends on how carefully it has been planned. Sometimes a specific case is described and then statements about it are discussed. Table 4–6 gives an illustration of such a case. Such cases are different only in detail from those occurring in every department of every industry day after day. They involve the same fundamental principles of human relations.

TABLE 4–6. A TYPICAL CASE FOR CONFERENCE IN SUPERVISOR TRAINING*

Gus had been foreman of a production department for 17 years. He was tough with his men but he got things done. When under pressure, he became loud and profane. He bawled men out frequently and would not tolerate opposition. He was boss in the full sense of the word.

When the department expanded, Gus had Herb made assistant foreman. Herb was quiet, capable, well-liked, and his appointment was approved by the men. Soon after this, Gus planned to change some equipment so as to step up production. Herb quietly protested that this would result in more crowded and hazardous working conditions. Gus interpreted this as an indication of Herb's disloyalty and loudly condemned him as swell-headed and trying to run the department. The men supported Herb in his judgment but this infuriated Gus who told Herb to "either do things my way or get out."

Consider the following statements regarding the above case.

1. Herb should ask for transfer to another department.
2. Gus should not be allowed to fire Herb or demote him.
3. Herb should take the case to top management immediately.
4. Herb should assist Gus, as he was appointed to do, and let Gus make the decisions.
5. Top management should fire Gus and appoint Herb in his stead.
6. Top management should call both men in and force them to cooperate for the welfare of the company.
7. Top management should allow Gus to fire Herb and run the department as he wishes so long as he gets the work done.
8. Gus is a man-driver and should never have been foreman.
9. Both Gus and Herb should be fired or demoted and a new foreman appointed.
10. The men in the department should decide what should be done.
11. Decision should be postponed to see if the trouble will blow over.
12. Neither man should "lose face." Both should be promoted.

* After National Industrial Conference Board, Selecting, Training, and Upgrading Supervisors, Instructors, Production Workers, *Studies in Personnel Policy,* No. 37, p. 71.

Another procedure is to have each member of the group present a specific problem of his own for discussion. This makes the conference even more practical and the course more valuable to its members. The author has found, however, that it is well to help the supervisor plan the description of his case. Often the omission of significant details and the inclusion of insignificant details misdirect the discussion which follows their presentation. Incidentally, this sort of conference is not only recommended for a training program, but it is also a good feature of the permanent procedure of a personnel department. At least once each month the supervisory staff of a plant should get together in groups of not over twenty each for conference and discussion of their respective problems of human relations.

The importance of delaying judgment in problems of human relations cannot be overemphasized. Too often decisions are made without careful study of the problem. Too often supervisors have been told that they should "make decisions promptly and stick to them." A wrong decision is worse than a decision that is never made. It is better to say nothing to a man than to say the wrong thing. Be sure you are right and *then* go ahead.

Sometimes the course in basic principles of human relations is combined with the course in specific problems in human relations, and principles are *induced* from a study of problems. This is the "case method" so generally used in the study of law. This method is time-consuming and results in a disorganized understanding of the *science* of human behavior. Facts are not discovered by armchair discussion. The best way for beginners to learn about the science of human behavior is to read about it or listen to an authority tell about it. Facts about the science of psychology should be discussed in order to be understood but not discussed in order to be discovered. The discussion of some local problem of personnel management will make psychological principles more meaningful, but principles must first be learned in order to be interpreted.

Selecting Supervisors. It was suggested in Chap. 3 of this book that it is easier to train a man if he has been carefully and appropriately selected for his job. A qualified man does not need so much training as an unqualified man. This is even more true of supervisors. Some men are temperamentally unsuited for supervisory work and no amount of training will remedy this limitation. Perhaps Gus, in the case given in Table 4–6, is such an example. It is doubtful if any amount of training would mold Gus into a good supervisor. He has personality characteristics which are not easily changed by training. Certainly it would be easier to train a man like Herb for supervision than one like Gus.

There are two important considerations in the selection of supervisors: What human traits are important in supervision? How can these traits be measured?

File and Remmers[17] have developed a test for measuring supervisory ability which has a reported reliability of .76 for the single form and .86 for both forms. It consists of 140 questions on supervisory practices, company policies, supervisor opinions, and typical problems of supervision. The authors report higher scores after supervisory training and for individuals with superior supervisory potentialities (critical ratio of 4.4). However, Sartain[18] found no relation between scores on this test and supervisory ability. He also administered the Otis Mental Abilities Test (Higher Examination), the Tiffin-Lawshe Adaptability Test, the Revised Minnesota Paper Form Board, the Bennett Test of Mechanical Comprehension, the Bernreuter Personality Inventory, and the Kuder Preference Record and likewise found no significant correlations with supervisory ability. His subjects were 40 supervisors in an aircraft company.

The National Industrial Conference Board[19] classifies the qualifications necessary in potential supervisors under three headings—health, technical knowledge, and personality traits Health should be good and age between 25 and 45. Technical knowledge should be appropriate and adequate. (The Board advocates drawing up a list of technical qualifications and then comparing each candidate with this list.) While it admits that no list of personality traits would meet with general agreement, the Board gives the following eight traits as desirable:

1. Ability to analyze and grasp new information; ability to learn.
2. Industry, resourcefulness, and persistency in attacking work problems.
3. Willingness to accept criticism; ability to view one's self objectively; sense of proportion.
4. Emotional stability; sense of humor.

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[17] File, Q. W., and Remmers, H. H., Forms A and B, *How to Supervise,* The Psychological Corporation, New York, 1945. See File, Q. W., The Measurement of Supervisory Quality in Industry, *J. Appl. Psychol.,* 1945, 29, 323–337; Studies in Supervisory Evolution, *J. Appl. Psychol.,* 1946, **30**, 421–425.

[18] Sartain, A. Q., Relation between Scores on Certain Standard Tests and Supervisory Success in an Aircraft Industry, *J. Appl. Psychol.,* 1946, **30**, 328–332.

[19] *Studies in Personnel Policy,* No. 37.

5. Judgment and reliability
6. Ability to inspire confidence and respect in others.
7. Capacity for decision; ability to make up one's mind.
8. Ability to express one's self orally; articulateness.

The board believes that men with these leadership qualifications will naturally grow out of an organization itself. "Such persons are likely to be known." They will constitute the personnel for presupervisory training courses outlined above. Some companies give a battery of vocational tests, as described in Chap. 4, to these individuals and interpret the results free of charge. If the presupervisory courses are given by an outside institution (college, university, or institute), the tuition is usually paid by the company. As training progresses, men are studied more carefully, both at work and in training. Soon those with superior supervisory abilities begin to stand out, and when the need arises, usually there is a logical man for the job. A good supervisory training program thus reduces the difficulty of selecting a supervisor.

TRAINING EXECUTIVES

It is the carefully considered opinion of the author, after many years of close contact with industry, that the most poorly trained and most inadequate functioning individual in modern industry is the policy-making, all-powerful, highly paid executive. He makes more costly errors in judgment than any of his subordinates. As a rule, neither his schooling nor his experience prepared him for the work he must now perform. His previous success in some other line of endeavor seldom concerned the formation of policies. He was a specialist and a good one. He knew engineering, or law, or sales, or management, or personnel, or public relations. He met problems as they arose and solved them—successfully. He performed his job as it was and he did it well, but he never determined objectives and policies. He never determined what principles would govern the solution of problems and the performance of jobs. He was guided by policies but he never created them.

Some of the more far-sighted companies are becoming concerned about this problem and are trying to correct it. They realize that some of their "top management" have made many and costly mistakes, mistakes that more intelligent and better trained men would not have made. They are beginning to see that being a successful executive takes more qualities of leadership than social status, or personal wealth, or ancestry, or success in some other field, or "influence," or personality charm. They are not very sure of what characteristics a good executive should have, but they want to find out what they are and then they want their executives to have those characteristics.

A number of studies have been made of executive characteristics but none of them are very convincing. They are largely the summarized opinions of executives themselves. Typical of these studies are the two which follow.

A few years ago Starch[20] asked three groups of executives to name and evaluate the characteristics which executives should possess. The top group was composed of 50 executives whose average salary was $80,000, the mid group of 50 executives whose average salary was $12,000, and the low group of 50 executives whose salary was $4,000. The results are given in Table 4–7. The first three items are characteristics of the executives themselves and the last four are the characteristics they rated.

TABLE 4–7. EXECUTIVE RATING OF EXECUTIVE CHARACTERISTICS

Item	Executive rank		
	Top	Mid	Low
Characteristics of executives:			
Salary average	$80,000	$12,000	$4,000
College graduate	72%	74%	20%
Grades (upper third)	68	66	32
Like their work	84	76	44
Characteristics rated:			
Ability to think	72%	58%	46%
Inner drive (hard work)	78	62	20
Assume responsibility	90	68	16
Ability to handle people	84	72	86

O'Connor[21] made a study of 100 presidents and vice-presidents of successful companies and found five distinguishing characteristics which he said he was able to isolate and measure. They were large vocabulary, many aptitudes, objective personality, accounting aptitude, and "aptitude for first position."

Other studies are of a similar nature and caliber. They all seem to agree, however, that *native intellectual ability* is an essential characteristic. No IQ is too high for an executive. Most of the studies agree that a *superior basic education* is important. They do not all agree that college graduation is essential but show that it is certainly no handicap. Perhaps if basic education is not defined as years of schooling, they would all agree that it is essential. Most studies agree that executives should be specifically *trained for executive function*. Top management is a field of specialization in which, unfortunately, there are too many charlatans.

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[20] Starch, D., *How to Develop Your Executive Ability*, Harper & Brothers, New York, 1943.

[21] O'Connor, J., *Psychometrics*, Harvard University Press, Cambridge, 1934.

The first two of these characteristics of good executives may be taken care of in the process of selection. Only men who are highly intelligent and who have superior general education should be chosen for executive training. No amount of training can compensate for low intelligence, and only an excessive amount of training can compensate for a poor education. It is important to choose potential executives who are intelligent and who are well-educated.

Both intelligence and education can be measured with a fair degree of accuracy. (Tests for these traits are discussed in Chap 3.) The Graduate Record Examination is probably the best test of education available and also gives an intelligence score (the verbal factor). While it is used at most colleges and universities, however, it is not as yet available to industries. A good substitute is the General Culture Test for education and the Ohio State Psychological Test for intelligence. However, if a man has graduated from a first-class college and has made good grades, it may be assumed without great error that he has a fairly high intelligence and a good education. This can be verified by other information (such as testimonials from his instructors and his work record), and testing may not be necessary.

The third executive requirement—good training—is not so easily taken care of as the other two. The higher the position in the occupational hierarchy, the more difficult it becomes to analyze the job and train men for it. Job tasks in the higher echelons are less routine and their exact nature is more difficult to predict. Executives must be trained to solve problems of administration, each problem being different from those that have preceded and those that will follow. Like a chess player, the executive must look ahead and predict accurately what the consequences of each move will be. If he makes a mistake, his company and all those connected with it must pay for his error.

Understudy. Many companies select promising young men, who are intelligent and have good educations, to act as assistants to various junior and senior executives. One may be assistant to the superintendent, another assistant to the comptroller, another assistant to the president.[22] They are allowed to sit in on conferences and observe the operation of the administrative department at close range. Often understudents migrate from one executive to another and thus learn all phases of the administration of a company. (This is not usually done on the higher levels.) Such understudy training is comparable to the interneship training of physicians.

Company Conferences, Lectures, Projects, etc. Those companies that have planned executive training programs usually have classroom instruction of some sort. It may be in the form of conferences, lectures, projects, moving pictures, or library reading. Usually the training program is in charge of an executive, sometimes of vice-president status. He may have a corps of teachers who are in charge of various phases of the training program, the number depending on the size of the company. Sometimes reports are required on conferences and lectures, or administrative projects and problems are assigned for solution, or even examinations are given on information supposed to have been learned. One company[23] has a "junior-executive board of directors" which consists of 16 individuals in the company who are considered promising executive material. This board discusses company problems and makes recommendations to the senior board. In this way the members of the junior board become familiar with specific executive problems and methods of handling them. Their meetings constitute excellent training conferences. Needless to say, the senior board also profits from the counsel of its junior understudy.

Problems considered in company conferences and classes for potential executives usually concern policies and basic principles of management rather than the course of action in a specific case. Many such problems duplicate those discussed in supervisory training. Others are quite like those discussed by the sales force in their training. Still others duplicate the problems discussed in the department of public relations. Executive training is in no sense apart from the company. However, the point of view in executive training is fundamentally different from that of training at any of the lower levels. The supervisor, for example, is interested in what to do in a specific case while the executive is interested in establishing a policy of handling that and other similar cases.

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[22] An "assistant to the president" must be distinguished from an "assistant president." The former is not an office and may refer to anyone who helps or assists the president. The latter is an office and the incumbent is appointed by official action.

[23] Reported in Scott, W. D., *et al., Personnel Management*, p. 296, McGraw-Hill Book Company, Inc., New York, 1941.

Affiliated Training. A rapidly growing practice is for companies to affiliate executive training with formal courses in related subjects at proximate colleges and universities. The tuition is usually paid by the company, and the instructor is often a member of the company staff but employed by the university to teach one or two courses. Such an arrangement exists between the Westinghouse Electric Corporation and the University of Pittsburgh. The courses here are on the graduate level, and many Westinghouse employees earn master's and even doctor's degrees. The executive training is in the School of Business Administration. (As noted later, another affiliated program is with the School of Engineering.) Many other universities cooperate with neighboring industries in similar affiliated programs.

In addition to the three characteristics of good executives just discussed—superior intellect, superior education, and superior training—perhaps another should be mentioned. A good executive should also be superior in personality stability. He should be relatively free from psychoneurotic symptoms. He should be in good physical health. He should be calm and unemotional even in tense situations. He should be able to relax and completely forget his administrative problems when he is at home and "off duty." He should enjoy his work and never worry about it. His sense of humor should be great enough to enable him to meet emotionally charged situations with an attitude of objectivity and keen impersonal judgment. He should control those under him with due consideration for their points of view and welfare. He should formulate and state his opinions on the basis of facts which he has carefully evaluated and interpreted. If he should become emotional, he should carefully avoid all contact with associates until he has regained his normal state of calm balance. A superior executive should have a superior personality.

TRAINING SPECIALISTS

Salesmen. The nature of salesmanship depends so much on the nature of the product sold that training methods which are effective in one situation are likely to be ineffective in another. Few companies, however, have studied the effectiveness of their methods of training salesmen, and evaluation is largely a matter of opinion. Some methods are more frequently used than others. A survey of 215 varied industries made by the National Industrial Conference Board[24] indicated that on-the-job training is most frequently used. The results of this survey are shown in Fig. 4–7. Companies vary greatly in the amount of training given to the sales force. One company, manufacturing office supplies and equipment, has a very comprehensive sales training program as indicated in the following quote:[25]

> We utilize practically all the accepted methods of training salesmen. They receive 60 to 90 days' preliminary training in the Sales Agencies. If during that period they prove their qualifications to successfully sell our product, they are brought to our home office to attend sales schools here for a period of from two to four weeks. Our sales schools at the home office are operated continuously. In addition to conducting sales classes for new men we periodically conduct what we term 'Post-graduate' schools for experienced salesmen to bring them up to date on our products and the application of those products, and to improve their selling technique. . . . Sales Agents conduct weekly sales meetings following regular programs outlined by the Sales Managers. These sales meetings are educational in character and serve very effectively to keep all members of the sales organization informed of the latest developments in selling methods, etc. Periodically, the Sales Managers hold Regional Meetings in different sections of the country, and they are attended by Sales Agents and salesmen and sometimes service-

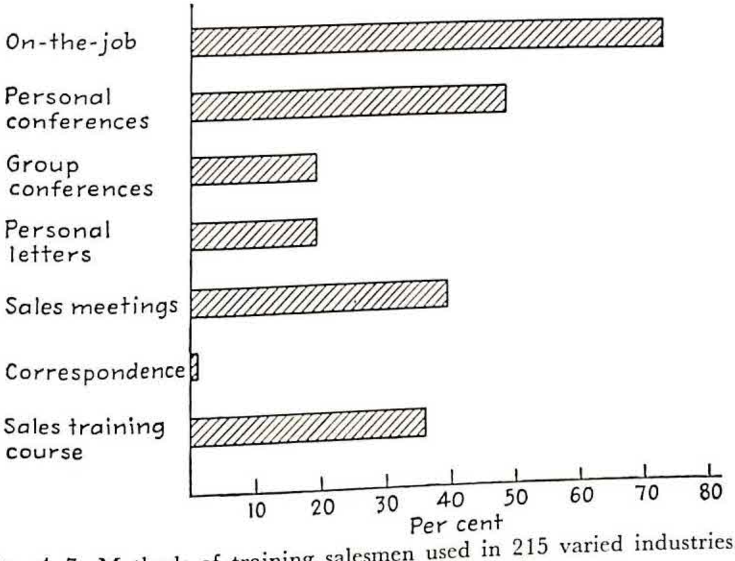

FIG. 4–7. Methods of training salesmen used in 215 varied industries.

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[24] *Studies in Personnel Policy,* No. 4.

[25] *Ibid.,* p. 8.

men in that section. We publish a weekly house organ to the sales organization, giving up-to-date information about selling methods, markets, sales opportunities, etc., as well as the quota scores to date for the month and for the year.

Salesmanship varies from across-the-counter distribution in the ten-cent store, to the house-to-house sales of brushes and insurance, to the highly specialized "contact work" of engineers in a company manufacturing pneumatic-control equipment, for example. The objective in all cases is to exchange products for money. In the ten-cent store, the exchange is immediate. In house-to-house "order taking," the exchange may be delayed for varied periods of time. In engineering contact service, the exchange is even more delayed. There is not even "order taking."

Basically, there are three phases of salesmanship training—knowledge of product, analysis of customer problems, and personality development. The importance of each of these aspects will vary with the nature of the product sold.

Knowledge of Product. There is little to be known about some articles and much to be known about others. A clothespin is a simple piece of merchandise, but the A-B valve on railroad car air-brake systems is a very complicated mechanism. Obviously, the time necessary to learn enough about the former to sell it is much less than that necessary to learn enough about the latter to sell it. Knowledge of the clothespin is assumed in salemanship training, but knowledge of the A-B valve, and other pneumatic equipment, requires several years of intensive training.

Some companies select salesmen only from production workers so that there is no question of their knowledge of the product. Others require their salesmen to spend brief periods of time in production work, on the assumption that they can learn about the product more quickly in this manner. Still other companies take their salesmen on conducted tours of the production departments and then have conferences and classes on other phases of the nature of the product. All companies keep their salesmen informed by printed information about the construction and composition of the products they are trying to sell.

Analysis of Customer Problems. Customer problems are of two kinds —real and imagined or "invented." The real problems deal with the function of the product, its comparison with competing products, the consequences of doing without it, how it is to be paid for, if it is worth its cost, etc. Imaginary problems are really "customer resistance." There is no real reason for not purchasing, so the customer argues. He invents reasons for not purchasing. He may be perfectly honest but his bogus arguments have determining weight.

Problem of the former type may or may not be solved by purchasing the salesman's product. A good salesman may advise the purchase of a competitor's product, or he may advise no purchase at all, if that seems to be the best solution for the customer. He is a specialized consultant who is interested in the welfare of the customer. The sale of his own product is secondary to the customer's welfare.

Problems of the latter type are psychological. The customer will benefit by purchasing the product but he invents reasons for not doing so. They are easily answered, but since they are his own personal arguments, it is difficult to answer them without offending him. "The customer is always right." He must discover that his resistance to purchase is unwise, but he must not "lose face." He must not associate the salesman or the product with his "shame of being wrong." Somehow he must be made to feel that purchasing the product is indicative of his own personal importance. His ego must be expanded, not deflated.

Problems of both types are excellent content for sales conferences. Of course there is always the danger of overgeneralizing, but the benefits of sales conferences far outweigh the dangers.

Personality Development. The first step in personality development in a sales training course is to learn what constitutes a good personality and what constitutes a poor one. Dodge[26] used the Bernreuter Personality Inventory and found that the following traits chracterized successful salespeople:

1. Less moody and worry less.
2. More self-confident and self-sufficient.
3. More aggressive and willing to assume responsibility.
4. More social.
5. Less self-conscious.
6. Less desirous of telling others of personal fortune.
7. Less resentful of criticism or discipline.
8. Consider self to be more radical or unconventional.

Canfield[27] reports a study of desirable personality traits as judged by purchasing agents. These traits are shown in Table 4–8. Salesmen in training should become familiar with these and other similar studies to learn what traits they should attempt to develop within themselves.

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[26] Dodge, A. F., What Are the Personality Traits of the Successful Salesperson? *J. Appl., Psychol.*, 1938, 22, 229–238.

[27] Canfield, B. R., *Salesmanship: Practices and Problems*, p. 54, McGraw-Hill Book Company, Inc., New York, 1940.

The second step in developing a good sales personality is to have it diagnosed so that the good traits and the poor traits are definitely known. Development cannot take place until it is known what to develop and what not to develop. This diagnosis is a complex procedure and cannot be described in the limited space available here. Needless to say, it should be attempted only by psychologists who are properly trained in clinical procedure. The average director of sales training is totally unqualified for such function.

TABLE 4–8. PERSONALITY TRAITS OF SALESMEN AS RATED BY PURCHASING AGENTS

Trait	Rank	Rating (possible 100)
Sincerity	1	82
Courtesy	2	82
Enthusiasm	3	80
Self-confidence	4	79
Self-control	5	77
Alertness	6	77
Appearance	7	76
Tact	8	75
Use of English	9	74
Aggressiveness	10	73
Voice quality	11	69

The third step is to cultivate those desirable personality traits that are now weak and to eliminate, or at least reduce, those undesirable personality traits that are now dominant. If one is not sufficiently self-confident, he should repress arrogance. But it is more difficult to change personality traits than generally supposed. On the adult levels, personality traits are rarely modified to any useful degree. It is easier to select salesmen carefully (choosing only those who do not have undesirable traits) than it is to try to remake the personalities of poorly selected salesmen. It is noble to make the effort, but the results are usually discouraging.

Engineers. The most the average engineering college can do is to give the student basic technical information which can be used in learning the particular type of engineering necessitated by the job he acquires after graduation. Like the physician, the engineer must serve a period of internship in which he learns to apply the things he learned in college.

The nature of postgraduate training for engineers depends on the specific nature of the work to be performed. For example, the "student apprenticeship training course for engineers" at the Westinghouse Air Brake Company is entirely different from the corresponding course at the Westinghouse Electric Corporation. Most of the students at the Air Brake are graduates in mechanical engineering, while those at the Electric are mostly graduates in electrical engineering. The specialized courses, the laboratory projects, the practical experience at the Air Brake concern pneumatic controls, while at the Electric company they deal with electrical functions.

The "pneumatic engineering course" at the Westinghouse Air Brake Company is highly specialized and runs for 9 months. The first 6½ months are devoted to formal training on the topics listed in Table 4–9. One month is then spent at practical work in the "design department" and another in the "test department." The final 2 weeks are spent in field trips to railroad properties, including the "switch and signal division" of the company. The "graduates" are then "assigned" to positions as determined by personal qualifications and company needs. Each class is limited to 12 men. There is a "training supervisor" who calls on key men in the company to assist him in various phases of the course. Needless to say, young engineering graduates are anxious to be chosen for this training course.

Other companies with different engineering problems have still different training procedures. The remuneration while in training varies, but is always adequate to maintain a normal standard of living. After training, the salary depends on the assignment and the qualifications of the man.

White-collar Employees. The National Industrial Conference Board found in a survey of 2,700 establishments in American business and industry that only 167 of them (6.2 per cent) had training programs for office workers.[28] The training of "white-collar" workers (stenographers, secretaries, receptionists, filing clerks, sales clerks, check girls, comptometer operators, payroll calculators, etc.) has never kept pace with the training of production workers. Nevertheless, as stated in another publication of the National Industrial Conference Board,[29] "employees are trained every day in every business organization, whether or not the management realizes it." Training is inevitable. The question is:

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[28] *Studies in Personnel Policy*, No. 20, p. 12.

[29] *Studies in Personnel Policy*, No. 36, p. 52.

TABLE 4–9. OUTLINE OF COURSE OF TRAINING FOR ENGINEERS AT THE WESTINGHOUSE AIR BRAKE COMPANY

Pneumatic Engineering Course

A. History of air brakes

B. Air-brake operations
  1. Air-brake fundamentals
  2. Air-brake devices
  3. Air-brake equipment
    a. Freight-car brakes
    b. Passenger-car brakes
    c. Locomotive brakes
    d. Traction brakes
    e. Vacuum brakes

C. Pneumatic-control equipment

D. Industrial (other than railroad) pneumatic controls
  1. Pneumatic control devices
  2. Pneumatic control equipment
    a. Marine equipments
    b. Aeropneumatic control equipment
    c. Compressor units
    d. Miscellaneous pneumatic-control equipment

E. WABCO methods
  1. Engineering
  2. Manufacturing
  3. Sales
  4. Patents
  5. Company policies

F. General
  1. Freight-train handling
  2. Passenger-train handling
  3. Association of American Railroads rules
  4. Interstate Commerce Commission requirements
  5. Bibliography

G. Training assignments
  1. Design department
  2. Development (test) department
  3. Commercial-engineering division
  4. District-office field work
  5. Special (depending on trainee)

Can it be planned and systematized in such ways that it will be more effective?

Some companies have very carefully planned training programs for their white-collar workers. These vary, of course, with the specific nature of the work performed. The method used by the American Telephone and Telegraph Company to train their clerical employees in the revenue accounting departments is more or less continuous on-the-job training. The jobs have all been analyzed and evaluated. They range from "routine manual operations" (such as mailing work, sorting toll tickets, assembling toll tickets) through "routine skilled machine operations" (such as typing toll statements, adding toll statements, preparing customer's bills on machines) to "knowledge of complicated matters" (such as service-order work and journal-reports work). A new employee is first assigned to "mailing work," for example, and given simple and informal training for that job. Then, when his seniority and ability justify, he is assigned to a training unit for promotion to the next higher grade of work. Again seniority and ability determine his eligibility for transfer to an advanced job when a vacancy occurs. "It is a basic rule of the training program that the senior student in training will be promoted to an advanced unit when an opening occurs and that the senior worker in the next lowest unit will be assigned to the class (in training) to fill the vacancy."[30]

Classes are held during working hours at the location of the job for which the training is being given. Training usually begins with sample work and then "turns to actual work as proficiency develops." For example, in typing toll statements the trainee first becomes familiar with the abbreviations and symbols used. She then learns to use a special-model typewriter on which two digits are combined on one key (such as .05, .10, .15, .20, etc.). The rest of the training is largely practice in developing dexterity in handling toll tickets and typing the toll bills.

The method of training in the "customer-service department" of the Philadelphia Electric Company is interesting. There are five jobs in this department of customer relations—office interviewing, field interviewing, telephone interviewing, correspondence adjustments, and on-and-off service work. The "background of all training materials" is a manual or handbook entitled *The Conduct of Customer Interviews.* The manual was written by supervisors and servicemen and edited by the training supervisor. It is frequently revised and thus continues to stimulate old employees and supervisiors as well as trainees. Homework assignments, examinations, and conference instruction are all part of the program. The general plan of training is as follows:

Part I

The Office Interview, Its Purpose and Its Methods

1. Distinctive features of office interview work
2. Office interview work from the customer's viewpoint
3. The things that customers expect

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[30] *Ibid.*, p. 6.

4. Employee characteristics involved in interview work
5. The general interview treatment

Part II

1. From generating station to customer's premises
2. Fallacies in the customer's premises
3. Interview treatment instruction
    a. Requests for electric service
    b. Requests for discountinuing electric service
4. Interview-treatment instructions
    a. *Handling* nonstandard service conditions
    b. Complaints regarding metering difficulties
5. Interview-treatment instructions
    a. Inquiries about pending service orders
    b. Customer claims of company responsibility for damage

Part III

Customer Cases Relating to Commercial Operations

1. From application for service to bill delivery
2. Payment, collecting, and closing customer accounts
3. Interview treatment instructions
    a. Requests for duplicate bills
    b. Requests for explanation of bills
4. Interview-treatment instructions
    a. Requests to waive delayed-payment charge
    b. Requests for special readings
5. Interview-treatment instructions
    a. Requests for extensions
    b. Requests for reconnections
6. Interview-treatment instructions
    a. Requests for refund of deposit
    b. Review questions on the commercial operations

The revision of the training manual then constitutes the basis for "continuation training" of those already employed. This is considered "even more productive than initial instruction." It takes the form of conference discussions of the value of procedures of customer relationships now in practice, and of suggestions for their reform. The fact that new ideas may go into the manual to be used in training new employees motivates the older employees to greater effort in devising new techniques of customer relationships.

The training of white-collar workers in other establishments follows patterns as peculiar to the specific needs of the situation as the two cases just described. The important factor is that some systematized training be used, rather than a nondirected and nonplanned procedure of self-training. White-collar jobs may seem simple to those acquainted with them, but to new employees they are difficult. Without proper direction, wrong procedures may be learned which can interfere with later efficiency.

SUMMARY

Basic principles of training and various patterns of training have been briefly outlined in this chapter. More thorough discussions of the basic principles of learning may be found in some of the books on educational psychology listed below. Discussions of patterns of training are scattered through a more varied literature. Perhaps the best single source is found in reports of the National Industrial Conference Board. Objective research material in this field it not too plentiful. Procedures of industrial training are now in a stage of development reminiscent of that of academic training a generation and more ago. Academic training made but little real progress until it developed research methods for objectively testing the accuracy of its procedures. There is little to indicate that industrial training can escape this same necessity.

In one of its reports,[31] the National Industrial Conference Board recommends that the "director of training" be made a member of top management. "To isolate him from the policy-making administrators is to render him so remote from key problems that his work becomes irrelevant, and hence ineffective." Training is more important than the average company realizes, and its proper status can be attained only if its director is found at the very top of management authority.

RECOMMENDED READINGS

Boring, E. G.: *Psychology for the Armed Services,* Chaps. 12–13, Infantry Journal, Washington, D.C., 1945.

Dodd, A. E., and Rice, J. O.: *How to Train Workers for War Industries,* Harper & Brothers, New York, 1942.

Gray, J. S.: *Psychology in Human Affairs,* Chap. 14, McGraw-Hill Book Company, Inc., New York, 1946.

Meier, N. C.: *Military Psychology,* Chap. 5, Harper & Brothers, New York, 1943.

Moore, H.: *Psychology for Business and Industry,* Chap. 9, McGraw-Hill Book Company, Inc., New York, 1942.

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[31] *Ibid.*

MORGAN, H. K.: *Industrial Training and Testing,* McGraw-Hill Book Company, Inc., New York, 1945.

National Industrial Conference Board: *Studies in Personnel Policy,* New York. No. 15, Training Solutions of Company Problems (Executive and Supervisory Personnel); No. 18, Training Solutions of Company Problems (Non-supervisory Production Employees); No. 22, Training Solutions of Company Problems (Sales Personnel); No. 26, Quick Training Procedures; No. 36, Training White Collar Employees; No. 37, Selecting, Training, and Upgrading Supervisors, Instructors, Production Workers; No. 49, Visual Aids in Industrial Training; No. 55, Time Schedules in Job Training; No. 66, Foreman Training.

PRESSEY, S. L., and ROBINSON, F. P.: *Psychology and the New Education,* Chaps. 11–15, Harper & Brothers, New York.

SCOTT, W. D., CLOTHIER, R. C., and SPRIEGEL, W. R.: *Personnel Management,* Part IX, McGraw-Hill Book Company, Inc., New York, 1949.

TIFFIN, J.: *Industrial Psychology,* Chap. 8, Prentice-Hall, Inc., New York, 1947.

VITELES, M. S., *Industrial Psychology,* Chaps. 19–20, W. W. Norton & Co., New York, 1932.

WALTERS, J. E., *Personnel Relations,* Chap. 10, The Ronald Press Company, New York, 1945.

YODER, D., *Personnel Management and Industrial Relations,* Chap. 9, Prentice-Hall, Inc., New York, 1942.

Chapter 5

METHODS OF WORK

- Process analysis
- Operation Analysis
  - Basic Principles of Motion Economy
    - Motion Related to the Use of the Body
    - Motion Related to the Work Place
    - Motion Related to the Design of Tools and Equipment
  - Units of Work
  - Job Standardization
- Stop-watch Time Study
  - Dividing the Operation into Elements
  - Taking and Recording Time Data
  - Rating Skill and Effort
  - Determining Allowances
    - Fatigue Allowances
    - Delay Allowances
    - Personal Allowances
    - Calculating Allowances
- Summary

In 1883, Frederick W. Taylor, a foreman with Midvale Steel Company, received a degree in mechanical engineering from the Stevens Institute of Technology. His major interest was in the problem: "What should constitute a proper day's work?" He believed that a standard day's work could be determined and accurately measured. In 1898, Taylor went to the Bethlehem Steel Company as a management engineer. He soon inaugurated a planning department where work methods were studied, special tools were designed, and a standard day's work was predetermined. If a man exceeded this, he was given a bonus.

One of the first job studies Taylor made was of an ordinary hand-shoveling operation. Four to six hundred men were employed to shovel iron ore, rice coal, pig iron, etc. Each man owned his own shovel and lifted weights ranging from 3.5 lb. of rice coal to 38 lb. of iron ore. After careful experimentation, Taylor found that a man could handle the maximum tonnage per day if each shovel load was 21.5 lb in weight. This meant that shovels of different sizes were necessary for handling different materials. Three years after Taylor introduced his reforms, the shoveling picture had changed as follows:

Reduction of labor force from 400 to 140 men.
Increased tons per man per day from 16 to 59.
Increased earnings per man per day from $1.15 to $1.88.
Decreased handling cost per long ton from $0.072 to $0.033.

"During the six months following, when all the work of the yard was on task work, the saving (to the company) was at the rate of between $75,000 and $80,000 per year."[1]

In 1885, Frank Gilbreth began learning the bricklaying trade. He soon noticed that skilled bricklayers used different methods of laying brick and that each bricklayer used two methods—a fast one and a slow one. This caused young Gilbreth to seek for "the one best method of laying brick." He first made detailed studies of methods and equipment used. He then devised new equipment which was more functional. He had the bricks and the mortar placed on a platform at hip height instead of down at foot level. He invented a scaffold which could be quickly raised short distances so that the working level could be kept constant as the wall went up. He then eliminated all unecessary movements. For example, he had the bricks placed with the best face and end in a given direction so that the flipping-inspection movements formerly necessary to select the best side to place out were completely eliminated. Gilbreth was able to reduce to 5 the 18 movements necessary to lay a brick and to increase the man-hours rate of laying brick from 120 to 350.[2]

In 1912, Gilbreth and his wife collaborated in originating a new technique of motion study, known as "micromotion study." Moving pictures were taken of job operations and then analysis was made of the film, frame by frame. The controlled camera speed made possible the exact timing of each element of motion. Later, they attached small electric lights to the hands of the operators and took pictures with a stereoscopic camera. This enabled them to make a third-dimension study of the movements of an operation and also gave them a minutely exact time record for each.

The above instances are typical of many that could be related from the histories of both Taylor and Gilbreth. They initiated time study and motion analysis in American industry. They were the original "efficiency experts" and the forerunners of what is now known as "scientific management."

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[1] Taylor, F. W., *The Principles of Scientific Management*, p. 71, Harper & Brothers, New York, 1911.

[2] See Gilbreth, F. B., *Motion Study*, p. 88, D. Van Nostrand Company, Inc., New York, 1911.

The efficiency of work is dependent on two phases of plant function: (1) the process flow of raw material into the plant, through each operation of processing, to its exit as finished material, and (2) each individual operation involved in processing. These will be discussed in the following pages under the titles Process Analysis and Operation Analysis.

PROCESS ANALYSIS

The analysis of process flow may be for an entire plant or for a single department within a plant. In either case, the first step is a detailed and exact description in graphic form of the movement of material as it enters the plant or department, where it is taken, what is done to it, where it goes next, etc. This is called a "process flow chart" and involves the use of standardized symbols. These are shown in Fig. 5–1. Figure 5–2 shows a typical process flow chart designed to be used by those who are acquainted with the plant. Often a process flow chart is accompanied by a plant-layout chart. This facilitates analytical study of the process by those who are relatively unacquainted with the plant. Such a chart is shown in Fig. 5–3.

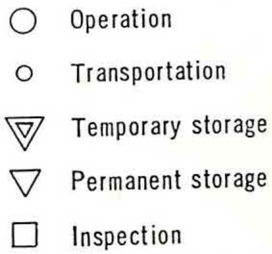

Fig. 5–1. Symbols used in making process charts.

There are three basic principles of process economy which should be carefully observed. These may be stated as follows:

1. Transportation of materials should be as automatic as possible (*i.e.*, mechanized) and over as short distances as possible. Long hauls and hand transportation are usually more costly than short hauls and mechanical transportation.

2. Storage of materials, whether temporary or permanent, should be kept at a minimum. Capital is invested in materials and long storage means idle capital. Processing should be prompt and reserve stock kept at a minimum.

3. The number of processing operations should be as few as possible and the sequences should require the least amount of handling. It is sometimes cheaper to use material which does not require certain processing operations at all. For example, the use of stainless steel may make a buffing operation unnecessary. Also, it is usually cheaper to operate machines which automatically feed and discharge the material than to operate those which must be hand-fed and hand-discharged.

1. $\bigcirc_{C}$ Unload steel bar stock from freight car by crane
2. ▽ Store in yard until needed
3. $\bigcirc_{C}$ Transport by crane to shear table
4. ○ Shear bars into billets
5. $\bigcirc_{H}$ Pile on skid by hand
6. $\bigcirc_{T}$ Transport skid to rotating furnace by truck
7. $\bigcirc_{H}$ Place billets in rotating furnace by hand tongs
8. ⛛ Billets in furnace
9. $\bigcirc_{H}$ Transport billets to descaler by hand tongs
10. ○ Descale billets
11. $\bigcirc_{H}$ Transport billets to upsetter by hand tongs
12. ○ Operate upsetter to form billets into cupped billets
13. $\bigcirc_{H}$ Transport billets to roll mill by hand tongs
14. ○ Operate mill to roll cupped billets into 75 mm. projectile cups
15. $\bigcirc_{H}$ Transport projectile cups to cooler hooks by hand tongs
16. ◦ Transport by cooler tow to inspection department
17. $\bigcirc_{H}$ Transport from cooler hook to skid by hand
18. ⛛ Store in skid until needed
19. $\bigcirc_{H}$ Transport to inspection table by hand
20. □ Inspect
21. $\bigcirc_{H}$ Transport to skid by hand
22. $\bigcirc_{T}$ Transport to shipping platform by truck
23. $\bigcirc_{H}$ Transport to freight car by hand

FIG. 5–2. Flow process chart for 75-mm. projectile cups.

All three of these principles were violated in the flow process shown in Figs. 5–2 and 5–3. However, this was a war contract and the processing was in a converted plant using converted machinery designed for another function. The demand for production was so great that efficiency and economy were sacrificed for expediency. There were obviously too much transportation by hand tongs and too many processing operations (descaler, upsetter, and roll mill). If more adequate machinery had been available, much handwork could have been avoided.

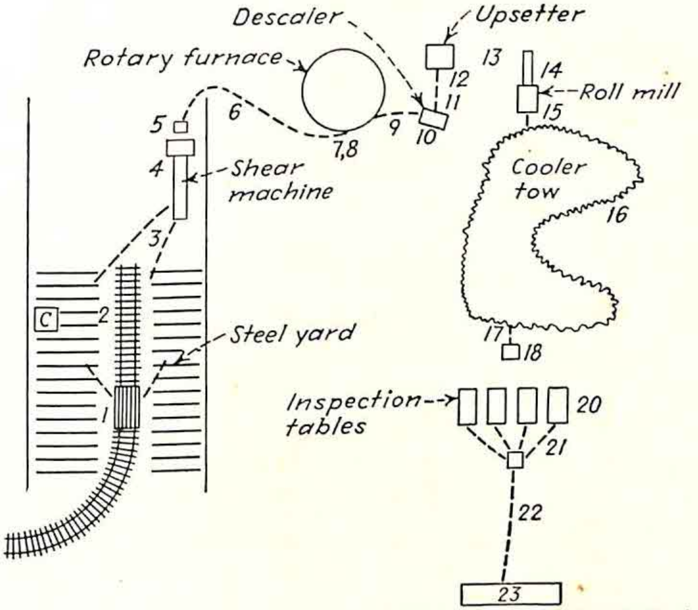

FIG. 5–3. Plant layout chart for processing 75-mm. projectiles. (Numbers refer to steps in Fig. 5–2.)

The improvement of a flow process involves the careful evaluation of each step in terms of its necessity, its place in the sequence, its complexity, and its duration. The following questions aid in this evaluation.

1. Can the step be eliminated?
2. If not, can it be combined with another step and thereby be reduced?
3. If not, can the sequence of steps be changed so as to eliminate effort, or time, or both?
4. Can the material be changed to that which is more easily processed?

Barnes[3] quotes a study by Koch of the flow process of making magnet armatures in which the number of operations were reduced from 31 to 28, the transportation distance was reduced from 5,710 ft. to 3,750 ft. (34 per cent), and the processing time per 100 pieces reduced from 16.0 hours to 11.5 hours (28 per cent). The same author reports another study of the process flow chart for "making, filling, and sealing rectangular cans for export shipping of instruments," in which improvement in the painting part of the process alone resulted in reducing the operations from eight to three, reducing the transportation distance from 12,295 to 5,050 ft., and reducing the total number of transport moves from nine to three.

OPERATION ANALYSIS

When the flow process in a plant has been carefully studied and all possible improvements made, it yet remains to analyze and study each individual operation in the process. Here again charts are constructed and symbols are used. They are usually in two synchronized parts, one for the action of the left hand and the other for the action of the right hand. However, hand movements are a small part of the many factors considered in operation analysis. Other factors are the materials processed; how they are handled; the tools, jigs, and fixtures used; the machinery setup and operation; the personal characteristics of the operator; the working conditions; etc. The following list of questions is suggestive of the many factors considered in an operation analysis.[4]

Materials

1. Can cheaper material be processed as easily?
2. Is the material in the best condition for processing?
3. If a new material could be developed, what should be its characteristics?

Etc.

Material Handling

1. Can handling distances be shortened?
2. Can the number of handlings be reduced?

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[3] Barnes, R. M., *Motion and Time Study,* p. 28, John Wiley & Sons, Inc., New York, 1940.

[4] For a more complete list of questions, see Maynard, H. B., and Stegemerten, G. J., *Guide to Methods Improvement,* McGraw-Hill Book Company, Inc., New York, 1944.

3. Can the handling be made more mechanical and automatic?
4. Can the containers or trays for handling be improved?
Etc.

Tools and Equipment

1. How can the tools be improved to reduce the operator's effort?
2. How can jigs be improved to reduce operator-precision requirements?
3. Are tools and equipment best located for ease of acquisition?
4. Are tools and equipment the best size for most efficient use?
Etc.

Machinery

1. Is the machine in best condition for fast and accurate operation?
2. How could the machine be improved in design to reduce the efforts of the operator?
3. Does the machine get out of adjustment too easily?
4. Can the speed of the machine be increased?
5. Can an automatic feed be designed and used?
Etc.

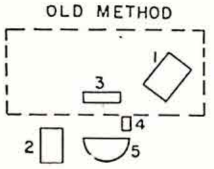
Operator

1. Is the operator properly trained to operate the machine?
2. Is he making any movements which could be eliminated, or performed more easily?
3. Are the materials and the controls all located within easy reach?
4. Is the base wage rate proper for the level of work performed?
Etc.

Working Conditions

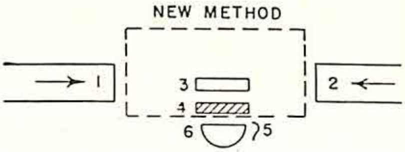
1. Are the light, heat, and ventilation satisfactory?
2. Are there noises, fumes, dust, or distractions which could be eliminated?
3. Are there any unnecessary hazards involved in the operation?
4. Are there adequate rest periods?
Etc.

The operation chart concerns only the movements made by the operator in handling materials, tools, jigs, fixtures, and machine controls. It shows exactly what is being done with both hands at all times during an operation cycle. Figure 5–4 illustrates both the old and new methods of a rather simple operation. The new method almost doubled production and produced less operator fatigue.



1. Box of unsealed packages (on table).
2. Box of sealed packages (on floor).
3. Sealing iron.
4. Foot pedal.
5. Seat.

Left Hand	*Right Hand*
Carry sealed package to box 2.	Reach for unsealed package in box 1
Release package.	Grasp package.
Return hand.	Carry package to sealing iron.
Grasp unsealed package.	
Position package in sealing iron.	Position package in sealing iron.
Step on Foot Pedal	
Carry sealed package to box 2. Etc.	Release package.
	Reach for unsealed package in box 1. Etc.



1. 2. } Conveyor belts
3. Sealing iron.
4. Chute.
5. Knee pedal
6. Seat.

Left Hand	*Right Hand*
Reach for unsealed packages on conveyor belt 1.	Reach for unsealed packages on conveyor belt 2.
Grasp package.	Grasp package.
Slide to jig on sealing iron.	Slide to jig on sealing iron.
Push Knee Pedal	
Slide package to chute.	Slide package to chute.
Reach for unsealed package on conveyor belt 1. Etc.	Reach for unsealed package on conveyor belt 2. Etc.

FIG. 5-4. Old and new operation charts for sealing cellophane packages.

BASIC PRINCIPLES OF MOTION ECONOMY

In 1923, the Gilbreths published a list of 16 rules for motion economy.[5] These have since been modified by various authorities. Lowry and his associates[6] have stated the principles of motion economy in five laws and eight corollaries. Barnes[7] has 22 principles and classifies them according to their function—those concerning the use of the human body, those concerning the arrangement of the work place, and those concerning the design of tools and equipment. The following statements of 12 principles of work movements are classified after that of Barnes but otherwise vary considerably from other statements.

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[5] Gilbreth, F. B., and Gilbreth, L. M., "A Fourth Dimension for Measuring Skill for Obtaining the One Best Way," *Soc. for Ind. Eng. Bull.*, No. 11, November, 1923.

[6] Lowry, S. M. Maynard, H. B., and Stegemerten, G. J., *Time and Motion Study,* Chap. 8, McGraw-Hill Book Company, Inc., New York, 1940.

[7] Barnes, *op. cit.*, Chaps. 12–14.

1. Motion Related to the Use of the Body.

The two hands perform their work more economically when: they begin and complete their movements at the same time; their movements are made simultaneously in opposite and symmetrical directions; and they are not idle at the same time except during rest periods. The observation of this principle results in a minimum of body strain and a maximum of habituation and rhythm of movement. It is most natural for the hands to move together in relation to the body as the axis. They thus tend to maintain body balance and reduce strain. This is illustrated by reaching for two pencils on the table in front of you, one at 45 degrees (deg.) to the right and the other at 45 deg. to the left. To alternate reaching takes twice as long as to reach for both simultaneously. If they are both placed to the right, reaching with both hands in the same direction throws the body off balance and requires additional muscle strain. These principles are simply statements of conditions of nature.

Motions performed with the least use of body anatomy are most economical of energy. There are five classifications of movements which use progressively more and more anatomy and consequently require more and more energy. They are

1. Finger movement.
2. Finger and wrist movements.
3. Finger, wrist, and lower arm movements.
4. Finger, wrist, lower arm, and upper arm movements.
5. Finger, wrist, lower arm, upper arm, and body movements.

Finger movements require least energy but they are limited in distance. However, some operations require movement through greater space than is possible with the fingers alone. Usually, such operations require more energy.[8] Some operation distances are necessarily so great that the whole body must function. Other things being equal, these of course require the greatest energy.

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[8] It does not necessarily follow that finger movements are less fatiguing than movements of the whole forearm. (See Stetson, R. H., and McDill, J. A., Mechanisms of Different Types of Movements, *Psychol. Monogr.*, 1923, 32, No. 3.) For example, it is more fatiguing to write with the fingers alone than it is with the whole forearm.

For the least use of body anatomy, materials and tools should be placed as close to the location of their use as is consistent with freedom of operation when they are not in use. Special bins for materials and special racks for tools are often designed to satisfy this principle of motion economy. This is known as '"prepositioning" tools and materials and is discussed further under No. 2 below.

It is economical to use momentum in work except when it must be counteracted by muscular effort. The momentum of tools or materials may do useful work. The stroke of a hammer is an example. On the other hand, momentum may necessitate muscular effort to stop it. A too-fast hand motion carrying material to the working area must be stopped as well as started by muscular effort. The expenditure of energy may outweigh the increase in speed. A slower movement may be more efficient in the long run. An example of possible hindering momentum is illustrated by the new operation in Fig. 5–4. If the conveyor belts operate too fast, the packages are deposited on the table with such momentum that they slide into the working area at the sealing iron.

Continuous curved movements are more efficient than straight-line movements which involve sudden stops and sharp changes in direction. This principle is closely related to the last one. If two movements can be combined, the momentum of the first will carry over and partly complete the second. This principle is frequently violated in the use of a sledge. Instead of making a single circular movement from the point of strike to the point of strike again, the sledge is often lifted to a raised striking position and then brought down to the point of strike. Some workmen even make three straight-line movements—to a half-raised position, to a full-raised position, and then to the point of strike. It is easier to swing with a sledge than it is to strike with a sledge.

Flowing movements are preferable to controlled movements. This principle is an implication of the last two. A *flowing* movement is initiated by muscle action and then allowed to continue by its own momentum. The proper swing of a golf club is only initiated by muscle action. The momentum of the club then continues the stroke, and contact with the ball is merely an incident in the stroke cycle. The arm muscles are relaxed after initiating the stroke. A *controlling* movement is one in which antagonistic muscles are constantly continuing and counteracting its progress. There is no momentum. Finger writing is a good illustration of controlled movement, while Spencerian "free-hand" writing is a flow movement.

So much for the principles of movement which are related to the use of the human body. Needless to say, when an operation has been studied and the movement sequences have been designed in accordance with the above stated principles, they should then be practiced by workmen (at first slowly and exactly) until they become habitual. With this habit formation will also come a rhythm of movement which will further facilitate performance. This is hard to explain and, for some workmen, very hard to develop. Perhaps it cannot be taught. Music of the proper cadence appears to facilitate the acquisition of work rhythm. See Chap. 10 for further discussion of this point.

2. Motion Related to the Work Place.

Tools, materials, and controls should be located at fixed places near the locale of their use and pre-positioned for use. If work is to become habitual, it must not be unnecessarily varied. Tools should always be found in the same place and in a position ready for immediate use. Handles should be placed in the direction of the operator. If they are used by the right hand, they should be located on the right; if by the left hand, they should be located on the left. If there are many tools, they should be located on a movable circular rack so that all are within reach. It must be remembered that the reaching area for the right hand is an arc with the right shoulder as the center, and the reaching area for the left hand is an arc with the left shoulder as the center. The *easy* reach area for the right hand is a smaller arc with the right elbow as the center, and for the left hand it is a similar arc with the left elbow as the center. These are also known as the "maximum working areas" and the "normal working areas." They are illustrated in Fig. 5–5. Tools and materials that are used often should be placed in the easy reach area and those less frequently used may be placed in the shoulder reach area.

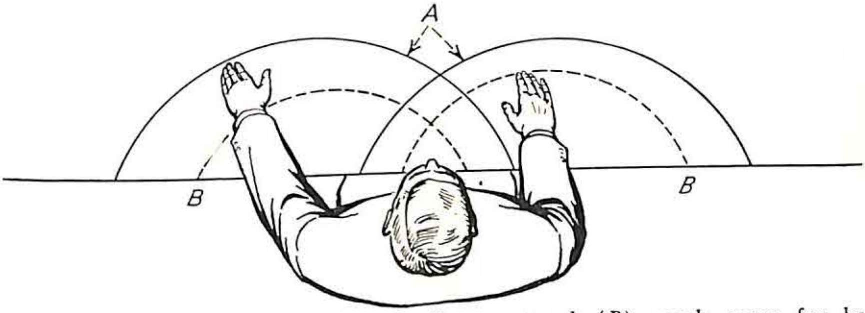

FIG. 5–5. Shoulder-centered (*A*) and elbow-centered (*B*) reach areas for both hands.

Frequently used tools are often suspended just above the working area. A screw driver may be so pre-positioned on an overhead spring, or lever arm, that it is ready for immediate use. Figure 5–6 illustrates such devices.

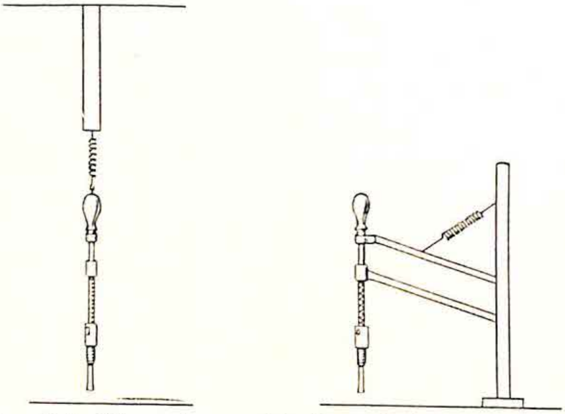

FIG. 5–6. Ways of prepositioning spiral screw drivers.

Materials may be mechanically delivered to the working area, as shown in the new method of Fig. 5–4, or they may be pre-positioned in bins arranged in a circular pattern within the reach area. Material bins

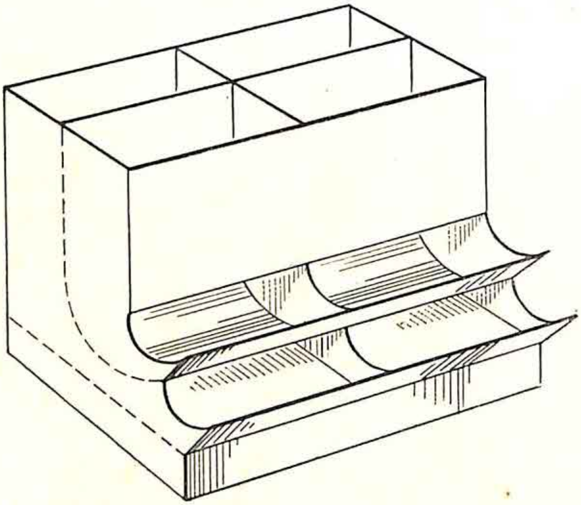

FIG. 5–7. A battery of hopper-type material bins.

are often equipped with trays which are fed from the bin by gravity. If a number of different materials are used the bins may be arranged in tiers, as illustrated in Fig. 5–7.

It is preferable to release processed materials into chutes which convey them to temporary storage by gravity. This principle is illustrated in Fig. 5–4, new method. Less energy is required to slide an article into a chute than to grasp and carry it to a bin.

Lighting should be appropriate for the work being done. The intensity of the light in foot-candles, the diffusion of the light, the source of the light, the color of the light, etc., affect both the quantity and quality of work. Work produces less fatigue when lighting is appropriate than when it is inappropriate. Chapter 11 is devoted to the subject of lighting so further comment here will be omitted.

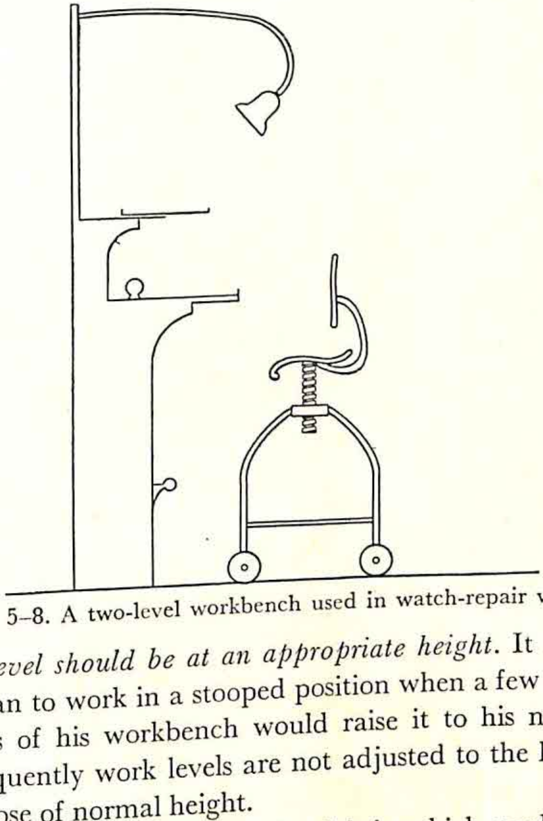

FIG. 5–8. A two-level workbench used in watch-repair work.

The work level should be at an appropriate height. It is foolish to require a tall man to work in a stooped position when a few blocks of wood under the legs of his workbench would raise it to his normal working level. Too frequently work levels are not adjusted to the height of workmen—even those of normal height.

A few years ago the writer studied a job in which small forgings were shoveled from the dumping platform of an oil quench to the trays of a drying furnace. Both levels were about 50 in. and the distance between them was 63 in. It was necessary for the workman to perform the entire shoveling cycle with both elbow angles at approximately 45 deg. The foreman objected to correcting the situation because the flow of material was so slow that "the job was a snap anyhow." However, as a matter of personnel relations, he finally agreed to an inexpensive 12-in. platform which raised the workman to a more normal height for shoveling.

When the worker operates while seated, the chair or stool should be adjustable in both vertical and horizontal directions. This enables either a tall or a short workman to adjust both to foot pedals and to table height. Often work tables are at standing height with a high chair provided for alternate standing and sitting.

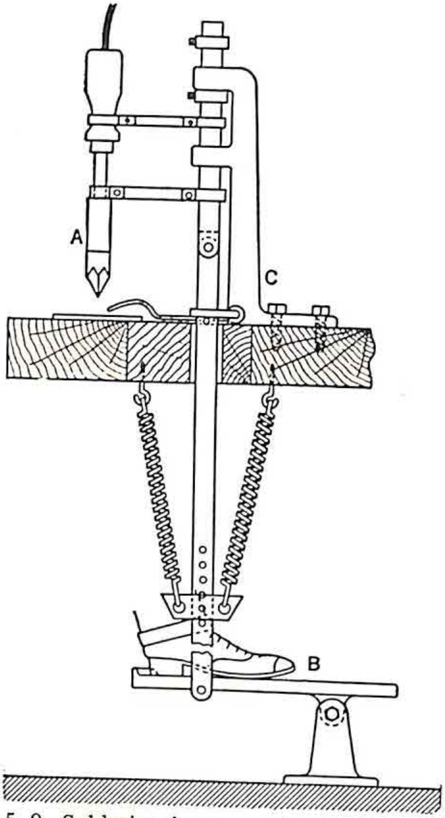

FIG. 5–9. Soldering iron operated by foot action.

It is often necessary to design equipment to satisfy this principle of motion economy. Figure 5–8 shows a two-level workbench and chair which the author designed for use in a horology (watch-repair) shop. It permits the workmen to either stand or sit, and to perform close work at the upper level and machine and grinding operations at the lower level. The chair is adjustable and comfortable.

3. Motion Related to the Design of Tools and Equipment.

Often other parts of the body can perform movements more economically than the hands. In many operations the hands are overworked while the feet and knees are idle. In his discussion of this principle, Barnes[9] shows a design for operating an electric soldering iron by foot action. This design is reproduced in Fig. 5–9. Note that the hands are free to position and hold objects being soldered. Barnes reports one use of this apparatus at a savings of 50 per cent in the time required. Many other machines can be more economically operated by foot and knee controls than by hand controls.

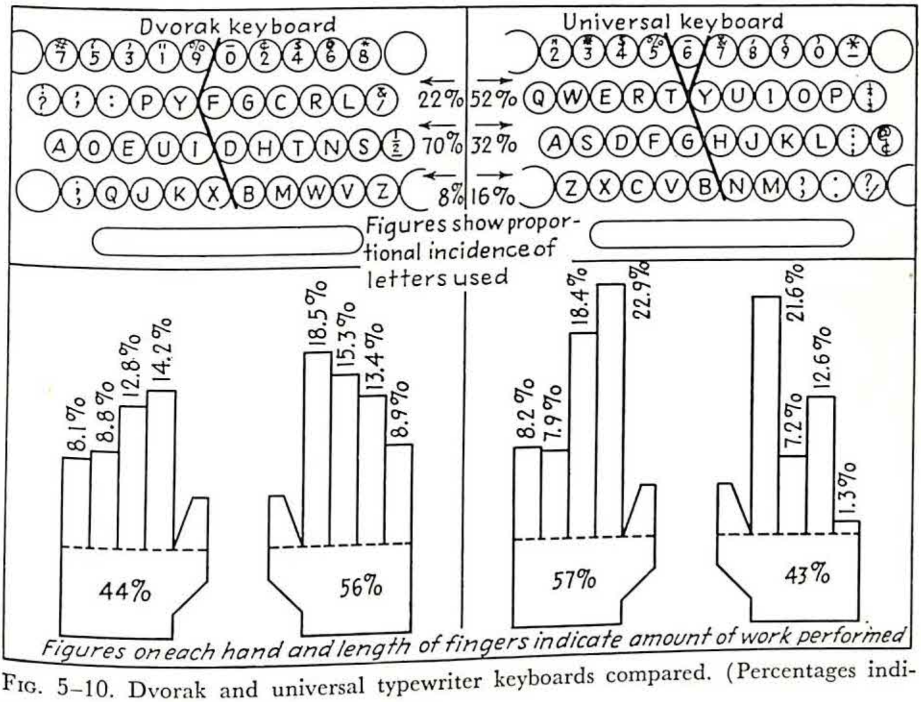

FIG. 5–10. Dvorak and universal typewriter keyboards compared. (Percentages indicate work load.)

Two or more tool functions can often be combined in a single tool. An example of a combination tool is the ordinary "Boy Scout knife," which has a knife blade, a can opener, a bottle opener, a screw driver, a reamer, and a punch. The ordinary household pliers have specialized parts which cut wire, hammer, hold pipe of various sizes, twist screws, etc. In industry it is common practice to combine a number of "go–no-go" gauges in a single instrument. During the war a woman "associate" in one of the Jack and Heintz plants designed a pair of pliers with a crank in one of the handles which would spin the jaws while the handles were held rigid. This facilitated her job of splicing the ends of two copper wires.

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[9] *Op. cit.,* p. 217 Design in Fig. 5–9 reproduced by permission of the publishers, John Wiley & Sons, Inc.

A hand operation can be performed more easily if it is distributed according to the inherent capacity of each hand and each finger involved. A right-handed person can perform a greater load with his right hand than with his left. However, a right-handed violin player finds it necessary to develop greater skill with his left hand than with his right. A left-handed person finds that the piano keyboard is in reverse for his own greatest efficiency. Perhaps the greatest violation of this principle is the ordinary typewriter. Fifty-seven per cent of the work load must be performed by the left hand. Also, the load is not distributed among the fingers according to their inherent capacity. Dvorak and his associates,[10] have developed a keyboard, shown in Fig. 5–10, which has the following advantages over the universal keyboard:

1. Easier to master, requiring less time to attain a particular level of speed.
2. Faster, since it makes higher net rates possible for average typists.
3. More accurate.
4. Less fatiguing.

UNITS OF WORK

In his search for the "one best way" of doing work, Gilbreth concluded that there are certain fundamental units in all work which can be identified. He called these basic units "therbligs"[11]—his own name spelled backward. He identified and described 17 therbligs (to which the therblig "hold" was later added) and then devised symbols to represent each. These are shown in Table 5–1. Gilbreth's procedure was to analyze a job and then describe it in therblig sequences, showing the exact time required for each. This micromotion study led to the use of the moving-picture camera, as mentioned earlier in this chapter. However, in most industrial situations the time required for therblig sequences is measured (less accurately to be sure) by the use of the stop watch.

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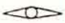
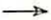
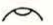
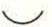
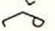
[10] Dvorak, A., Merrick, N. I., Dealey, W. L., and Ford, G. C., *Typewriting Behavior,* American Book Company, New York, 1936.

[11] Gilbreth, F. B., and Gilbreth, L. M., *Fatigue Study,* The Macmillan Company, New York, 1919.

TABLE 5–1. THERBLIGS AND THEIR STANDARD SYMBOLS

Therbligs	Symbols		Meanings
1. Search		Sh	Eyes or hands are hunting for an object
2. Find		F	Object is discovered (not often used)
3. Select		St	Making a choice of one object from several
4. Grasp		G	Closing the fingers on an object
5. Transport loaded		Tl	Moving an object
6. Position		P	Turning or placing an object
7. Assemble		A	Fitting two or more objects together
8. Use		U	Manipulating an object
9. Disassemble		Da	Separating one object from another
10. Inspect		I	Checking an object with specifications
11. Pre-position		Pp	Placing object for the next operation
12. Release		R	Relaxing the fingers from a grasp
13. Transport empty		Te	Moving the empty hand
14. Rest		R	Resting to overcome fatigue
15. Unavoidable delay		Ud	Waiting which cannot be avoided
16. Avoidable delay		Ad	Idling
17. Plan		P	Deciding how to proceed
18. Hold		H	Retaining an object after it has been grasped

JOB STANDARDIZATION

When the best way of performing a job has been determined, careful records should be made of the proper therblig sequences in the form of a job breakdown, similar to that shown in Tables 4–2 and 4–3, and an operation chart, similar to that shown in Fig. 5–4. Workmen should then be trained to perform the job exactly according to the determined procedure. Frequent checks should be made to be sure that the new procedure is being followed. In short, the improved job operation should become fixed, or standardized.

STOP-WATCH TIME STUDY

After the process flow and the job operation have been studied and standardized, it yet remains to time-study the job so that a standard production rate can be established and, from that, a proper wage rate set. This may be done by timing the entire operation cycle, but it is more accurately done by timing therblig sequences, called "operation elements." (Separate therbligs are too short to be timed with a stop watch.) The timing device used for this is a minute-decimal or an hour-decimal stop watch. (A split-second stop watch, like those used in athletic events, is seldom used in industrial time-study work.) Repeated time records are taken for the performance of each operation element.

There are four important steps in the procedure of time study: dividing the operation into elements, taking and recording time data, rating skill and effort, and determining allowances.

DIVIDING THE OPERATION INTO ELEMENTS

An operation element should be a distinct, single, continuous part of a task which has a definite beginning and ending. Three rules should be observed for dividing operations into elements:

1. Elements should be as short as is consistent with accurate timing. Duration units of less than 2 seconds (0.033 decimal minute, or 0.00056 decimal hour) are too short to time accurately.
2. Machine time should be separated from handling time. That is, a machine operation that does not involve the action of the operator should be timed separately.
3. Constant elements should be distinguished from variable elements. Constant elements are those that are independent of the materials being processed. Variable elements are those that are peculiar to that operation. For example, touching a soldering iron to a bar of solder is a constant, while applying it to the seam of a tin can is a variable.

TAKING AND RECORDING TIME DATA

The time observer should stand in a position which is close enough to enable him to see the hands of the operator and far enough away to avoid interference and distraction. The stop watch should be attached to the record board and held high enough to be seen easily. There are four ways of making stop-watch readings—the continuous method, the snap-back method, the accumulative method, and the cycle method.

In the *continuous* method, the watch is started at the beginning of the work cycle and is not stopped until the end of the cycle, or perhaps until the end of the observation period. At the end of each work element the time is noted and recorded. The time for each element is then computed by subtracting the recorded time at its beginning from the recorded time at its end. This is perhaps the most common method of taking time.

In the *snapback method* (also called the repetitive method), the watch is snapped back to zero at the end of each work element. The time recorded is thus for the actual time of each element. However, there is a time loss involved in reading the time and snapping the watch button for the next element. This amounts to at least 2 per cent on a total time study. Another disadvantage is that "foreign elements" or false motions are often not timed at all. Thus the sum of time for all the elements does not equal the elapsed time.

The *accumulative method* corrects the error of the snapback method by using two watches connected in such a way that one is started when the other is stopped. Thus, when the button is pressed at the end of one element, the other watch is automatically started to time the next element. The reading is made on the first watch and the hand returned to zero, ready to start when the second watch is stopped.

The *cycle method* is used to time very short elements. All are timed together, and then all less one are timed. Each element is alternately omitted, and the time of each finally determined by calculation. For example, if elements A, B, C, D, and E take 0.11 decimal minute, and elements A, B, C, and D take 0.08 decimal minute, by subtracting it is found that element E takes 0.03 decimal minute.

RATING SKILL AND EFFORT

It is obvious that the time required to perform a job depends on the skill of the operator and the effort he makes to perform the job rapidly. A time study of a highly skilled workman operating at his top speed will certainly be much less than that of a less skilled workman operating at a low speed. Consequently it is essential that a workman being timed also be rated on both his skill and his effort. In other words, the level of a workman's performance must be determined in a time study.

A common procedure is to rate a workman 100 if he is average, 110 if he is 10 per cent above average, and 90 if he is 10 per cent below average. There are many variations of this procedure.

A more complicated method has been developed by Westinghouse Electric and Manufacturing Company and reported by Lowry.[12] Degrees of skill are divided into six general levels and these further subdivided into eleven levels. Each of these is given a numerical value. (Two other factors are also rated—conditions and consistency—but are omitted here for simplicity.) These values are shown in Table 5–2. A workman is rated on both skill and effort. The numerical values of his ratings are added algebraically to the value of 1.00. This is his leveling factor and is used to correct his observed time.

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[12] Lowry, Maynard, and Stegemerten, *op. cit.*, Chap. 18.

The procedure of calculating time for a working element is to compute the average time from the total number of observations (omitting those that are atypical) and then to multiply this by the leveling factor obtained by the use of Table 5–2. This will be the standard time for performing that work element. For example, if the total of 14 observed times for an element is 0.0299 hour, the average would be this amount divided by 14, or 0.00214 hour. If the skill is rated B1 (+0.11) and effort is rated E2 (—0.08), the leveling factor will be 1.03 (0.11 — 0.08 + 1.0 = 1.03). Multiplying 0.00214 by 1.03, we have 0.002204, the standard time for this element. The standard time for an entire work cycle would, of course, be the sum of the standard times for all the work elements composing the cycle.

TABLE 5–2. SKILL AND EFFORT RATING SCALE

Skill			Effort		
Degree	Symbol	Value	Degree	Symbol	Value
Superskill	A1	0.15	Killing	A1	0.13
	A2	0.13		A2	0.12
Excellent	B1	0.11	Excellent	B1	0.10
	B2	0.08		B2	0.08
Good	C1	0.06	Good	C1	0.05
	C2	0.03		C2	0.02
Average	D	0.00	Average	D	0.00
Fair	E1	−0.05	Fair	E1	−0.04
	E2	−0.10		E2	−0.08
Poor	F1	−0.16	Poor	F1	−0.12
	F2	−0.22		F2	−0.17

DETERMINING ALLOWANCES

Standard time, sometimes called "base time," indicates the rate at which an average workman should produce if he worked steadily without fatigue or delays of any sort. Because this is impossible, allowances must be made for necessary interferences. The time-study man must make these allowances as accurately as possible.

Allowances may be grouped under three classifications—fatigue allowances, delay allowances, and personal allowances.

Fatigue Allowances. The fatigue produced by a job varies with both the nature of the job and the fatigability of the workman. The operation of a large 12,000-lb. steam hammer processing "two-man" forgings under typical forge-shop conditions is more fatiguing than the operation of a drill press processing small pieces under typical machine-shop conditions. However, both are fatiguing, and time allowances must be made for both. There are also great differences between operators in this susceptibility to fatigue. If the data in Table 1–4 (in Chap. 1) are plotted on a graph, the varying degree of fatigue becomes obvious. This problem of fatigue and recovery, or rest, is more fully discussed in Chap. 8. Here its existence is merely recognized as a factor for which the time-study man must make a time allowance.

Delay Allowances. Delays are due to a large number of factors which are usually classified as avoidable and unavoidable. Avoidable delays are characteristic of certain workmen and are not considered in calculating time allowance. Unavoidable delays are not characteristic of certain workmen and are considered in calculating time allowance. Unavoidable delays may be due to machinery malfunction, or abnormal materials, or inefficient fellow workmen, or interruptions by supervisors, or inadequately ground tools, or other similar factors. Whatever the nature of unavoidable delays, they must be recognized and evaluated in time study. Delays that are necessary and inherent in the job must become a part of the job time.

Personal Allowances. Usually from 3 to 5 per cent is allowed for this factor, with women workers given 2 or 3 per cent higher allowance than men. The variable here is not usually the nature of the job.

Calculating Allowances. The allowance percentage may be estimated after cursory observation, or it may be determined by careful time study. In the procedure of observing time, all "foreign elements" should be noted and also timed. If the number of these are greater than the space on the time record sheet provides for, a special allowance sheet may be used. Then, after fatigue, delay, and personal time losses have been observed for several operators for several days, an average percentage can be calculated. This is then added to the standard time already obtained and the final allowed time for the operation is determined. For example, suppose that this allowance percentage is 15, and we add this to the 0.002204 hour in the illustration used above. This would give us a total allowed time of 0.002535 (0.002204 × 0.15 + 0.002205) for this work element.

SUMMARY

Some of the more direct procedures used in industrial plants for increasing the effectiveness of human efforts have been briefly outlined in this chapter. Methods of studying the over-all flow of material through the plant were reviewed and illustrative charts were given. Some of the important principles of motion economy were stated and briefly outlined. Then, the procedure of stop-watch time study was outlined. Too often time study and motion analysis are confused. Time study may be used in motion analysis, or it may be used entirely independent of it. Considerably less training and ability are required for making time studies than for making motion-analysis studies. "Time and motion studies" must be recognized as two discrete and not too closely related procedures.

RECOMMENDED READINGS

BARNES, R. M.: *Motion and Time Study*, John Wiley & Sons, Inc., New York, 1940.

GILBRETH, F. B., and GILBRETH, L. M.: *Applied Motion Study*, Sturgis and Walton Co., New York, 1917.

HOLMES, W. G.: *Applied Time and Motion Study*, The Ronald Press Company, New York, 1938.

LOWRY, S. M., MAYNARD, H. B., and STEGEMERTEN, G. J.: *Time and Motion Study*, (3d ed.) McGraw-Hill Book Company, Inc., New York, 1940.

MAYNARD, H. B., and STEGEMERTEN, G. J.: *Guide to Methods Improvement*, McGraw-Hill Book Company, Inc., New York, 1944.

SAMPTER, H. C.: *Motion Study*, Pitman Publishing Corp., New York, 1941.

TAYLOR, F. W.: *Principles of Scientific Management*, Harper & Brothers, New York, 1911.

Chapter 6

WAGES AND MERIT RATING

- Factors Affecting Remuneration
  - Economic Conditions
  - Production Efficiency
  - Profit Demands
- Methods of Remuneration
  - Payment for Measured Time
  - Payment for Measured Production
  - Payment for Superior Production
    - The Taylor Penalty Plan
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    - Bonus Payment Based on Selling Price of Product
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    - Bonus Payment Based on Volume of Production
    - Bonus Payment Based on Cost of Living
- Worker Evaluation
  - Methods of Merit Rating
    - Rank-order Rating
    - Man-to-man Comparison
    - Scale Method
    - Check-list Method
  - Reliability of Merit Rating
- Summary

Men work to satisfy many motives, but most of them are obtainable by purchase. It is true that surveys show that "opporunity for advancement," "steady work," "good working conditions," and "good supervision" are often rated by workmen as more important than high wages.[1] Nevertheless, the rate of remuneration is still fundamental. Tiffin and Lawshe[2] found that during three war years (1942 to 1945) 44 per cent of the demands made in 821 dispute cases coming before the National War Labor Board concerned remuneration issues. Whatever else may motivate men to work, the pay they get is important.[3]

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[1] For example, see Chant, S. N. F., Measuring the Factors That Make a Job Interesting, *Person. J.*, 1932, 11, 1–4.

[2] Tiffin, J., and Lawshe, C. H. War Labor Board Decision Trends, *Person. J.*, 1945, 22, 78–83.

[3] Other motivating factors are discussed in Chap. 13 of this book.

Too frequently wages, like Topsy, just "grow up" without any intelligent effort to determine them according to affecting factors. A few years ago the author cooperated in the job evaluation of a plant in which some jobs carried wage rates far below their proper levels. Others were above their proper rates. The correlation between job rates and job values, as determined by job evaluation, was .57.[4] Labor unions, government supervision, public sentiment and labor supply have all been instrumental in raising over-all wages, but the isolated underpaid jobs and the isolated overpaid jobs still exist.

FACTORS AFFECTING REMUNERATION

While the industrial psychologist is primarily interested in pay methods, job evaluation, and merit rating, he must recognize that there are still other factors which determine the amount of money which is available for wages and salaries. High wage rates (in comparison with the prevailing wage scale) often make these other factors psychologically unimportant,[5] but they, in turn, often make high rates economically impossible. The psychologist must recognize these factors and accept them as determining limitations.[6]

Economic Conditions

The economic conditions of the country vary all the way from periods of intense depression, like the 1930 decade, to periods of "boom times," like 1928 and 1947. Such periods are marked by contrasts. In depressions, money is scarce and credit is restricted. There is less demand for commodities and prices are reduced. This curtails profits and production begins to decline. Payrolls are reduced and the general buying power is further limited. Production is increasingly restricted and the vicious spiral continues. Business refuses to operate without profit and the consumer does not have the money to buy.

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[4] This correlation is low. In a neighboring plant the correlation between job evaluation and wage rates was .82.

[5] An example of this was Jack and Heintz, Inc., which, during the Second World War, paid wage rates higher than the prevailing rates in the Cleveland area. In spite of the absence of many generally accepted wage procedures (incentive pay, job evaluation, merit rating), the morale among the workmen in this plant was unusually high. See Chap. 13 for further discussion of this point.

[6] Of course other costs as well as wage rates are affected by these factors. Cost of raw materials, costs of processing other than labor (machinery, management, etc.), cost of distribution, and the sale price are all affected.

In boom times, the picture is reversed. Money is plentiful and credit is easily obtained. Commodities are bought freely at prices far above the cost of production. Profits are great and production facilities are expanded. Payrolls increase and general buying power grows accordingly. More industries are created and the spiral continues.

Why periods of prosperity cannot continue indefinitely is a moot question. One theory is that the profits become so great ("middlemen" increase greatly during periods of prosperity) that the producer's income is not enough to carry the difference between the cost of production and the cost to the consumer. (It is claimed that real wealth is created only by producers.) If there is no outside source of income (foreign markets or consumer savings) purchasing decreases, goods pile up, and a depression begins. This theory claims that no economic system can carry a profit load without an outside market. Income always limits the ability to purchase. When the consumer's income and the cost of production are identical there can be no profits and production stops. People cannot pay more for goods than they are paid to produce them. However, if the consumer has savings that he is willing to spend, or, if production is subsidized and profit guaranteed by the creation of a national debt, the prosperity may be prolonged.

Another theory is that depressions are due to psychological factors. After a prolonged period of prosperity some people become fearful that it will not continue. They begin, slowly at first, to curtail their risks. As the fear grows the attempts to cash in on risks grow, and a depression is soon in full swing. The theory is that easy credit, fundamental to boom time, is a psychological state of mind.

There are many other theories of the causes of prosperity and depression. Perhaps all of them have elements of truth and perhaps none of them are adequate to guide economic planning. Regardless of cause, economic conditions certainly affect the amount of money which is available for wages and salaries.

Production Efficiency

A firm that can process materials with a minimum of waste of time, effort, equipment, and materials, will have more money available for wages and salaries, other things being equal, than will a firm that is less efficient. The various factors which affect production efficiency are discussed in the several chapters of this book. This chapter concerns remuneration in its effect on production efficiency. The countereffect of production efficiency on remuneration, or at least of the money available for remuneration, is here recognized.

PROFIT DEMANDS

It is an accepted fact that, when companies have strong overhead demands for large profits due either to overcapitalization or mere stockholder avarice, there is less money available for wages and salaries. When a company has a wage and salary schedule higher than that of its competitors, it is very often one that has no large group of absentee stockholders demanding profits. A prominent electrical company that is noted for its high wage scale is almost entirely owned by its president and employees themselves. Furthermore, it is not overcapitalized. Its profit demands are modest in comparison with those of many of its competitors.

Of course, if our economy were one of totally free competition, those companies with low production efficiency and high profit demands could not long survive. Their more efficient competitors who operate with lower profits would undersell them and customers would soon cease to purchase their products. Only the "fittest" companies would survive. However, with "cartels" functioning both internationally and intranationally, even inefficient companies often continue to operate at a profit.

But it is not within the province of industrial psychology to evaluate our economic system. Whether it is good or bad, it is a framework within which the industrial psychologist must function. Economic conditions, production efficiency, and profit demands are all factors which affect the amount of money a company is going to have for its payroll.

METHODS OF REMUNERATION

Methods of wage payment may be classified in three groups—those based on measured time, those based on measured production, and various combinations of these. In a survey of 2,700 companies in 1939, the National Industrial Conference Board[7] found that 51.7 per cent used wage-incentive plans of some kind. (This was a decrease from 74.6 per cent found in 1935 in a similar survey.) However, 75 per cent of the companies engaged exclusively in manufacturing (900 in number) used measured production as a basis of pay.

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[7] National Industrial Conference Board, *Studies in Personnel Policy*, No. 20, New York, 1949.

Payment for Measured Time

Payment for time worked is the oldest method of wage payment and, if "white-collar workers" are included, is yet the most common method. The rate may be per hour, per day, per month, or per year. It is not for an amount of work done but for a duration of time worked. Labor unions usually favor this method of payment and certainly it has many advantages. Often the amount of work cannot be measured and payment for time is the only method possible. Sometimes the work is so variable that to measure it and set piece rates would be uneconomical. When quality of product is more important than quantity, any method of incentive pay results in a reduction of quality. Also, when working conditions make delays and interruptions unavoidable, it is more satisfactory to pay workmen for straight time.

On the other hand, there are disadvantages to this method of wage payment. There is less incentive for increased individual performance. Increased pay does not result, at least immediately, from increased production. In fact, when there is a scarcity of work, time-paid workmen often slow down in order to drag employment out over a long period. This makes the prediction of labor costs more difficult and the calculation of unit costs less exact. Planning is thus handicapped. Finally, ambitious and superior workmen are not rewarded financially, and there is a tendency toward mediocrity.

Payment for Measured Production

The simplest alternative to payment for measured time is payment for measured production. This is called "piece rate," in contrast with "time rate" just discussed. Payment for the amount of work done, rather than for the time spent in doing it, has many advantages. Men work harder and produce more per hour. This results in higher wages for the workman and reduced cost to the employer. (His per unit cost for the processed article is no less if he bases piece rates on past costs of production, but his overhead fixed investment in plant and equipment is now producing more per time period and consequently his over-all cost is reduced.) Ambitious workmen can now develop greater skill and get paid for it. Employers can now calculate the unit cost of production and bid on jobs with greater accuracy.

However, there are many disadvantages to the piece-rate method of wage payment. It is difficult to keep production conditions uniform so that piece rates are equally appropriate at all times. Unprocessed materials vary, machines differ, delays are unavoidable, overworked men become irritable, and what was once a smoothly operating plant becomes a scene of confusion. Quality is sacrificed for quantity and the cost of inspection increases, machines and equipment are poorly tended and cared for, salvaging operations must be introduced, and what was initially a reduced per unit cost is now greatly increased. All this "speed up" for increased wages probably shortens workmen's lives. As Adam Smith said many years ago, "workmen, when they are liberally paid by the piece, are very apt to overwork themselves, and to ruin their health and constitution in a few years."[8]

Payment for Superior Production

Frederick W. Taylor's primary interest was in the problem: What should constitute a proper day's work? His time studies were all directed toward answering this question. Today, the industrial engineer can time-study a job and determine within a reasonable accuracy limit just how much the average workman should do in an 8-hour workday. This is called a standard day's work, or standard production. A number of wage-payment plans reward workmen for surpassing this standard amount.

The Taylor Penality Plan. Taylor believed that an inferior workman should be penalized for producing less than a standard day's work, or "less than task." His plan operated as follows: Suppose that 100 pieces per day is standard and that 5 cents per piece is the standard rate. An average workman will produce 100 pieces and so make $5 per day. A superior workman who produces 200 pieces per day will make $10 per day. However, an inferior workman who can produce only 90 per day will receive but 4 cents per piece and so make but $3.60 per day. Superior workmen are thus encouraged and paid to produce more, while inferior workmen are discouraged and will likely quit for a job more in line with their qualifications. The plan is a sort of Darwinian "survival of the fittest" which forces job adjustment by encouraging superior workmen and discouraging those who are inferior.

Premium Plans. The "Halsey plan" pays a standard time rate to average and inferior workmen (a guaranteed minimum) and a premium to superior workmen for the time saved (usually 50 per cent of the time rate). In other words, a superior workman will be paid the standard rate plus one-half the standard rate for production above the standard amount. If the standard production is 100 pieces per day and the standard rate 50 cents per hour ($4 per day), a superior workman would be paid 75 cents per hour for producing 200 pieces or $6 per day (the base pay plus one-half the savings). In other words, he does not get full rate for production above standard.

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[8] *Wealth of Nations,* Book 1, Chap. 8.

The "100 per cent premium plan" allows the workman full payment for all time saved. In this respect, it is like the Taylor plan, but there is a guaranteed base instead of a penalty for substandard production.

Other premium plans which vary from those just described only in minor details are the Gantt Task and Bonus Plan, the Barth Premium Plan, the Ficker Machine Rate Plan, the Rowan Premium Plan, the Emerson Efficiency Wage Plan, and the Baum Differential Gain Sharing Plan.

The Bedaux Man-minute Plan. The Bedaux plan reduces all work to standard units, man-minutes, called "B's." Each job is composed of a certain number of B's and a workman who can complete 60 B's in 30 minutes is paid a bonus for performance above standard. The bonus is less than full rate for the time saved but may reach as high as 75 per cent. The remaining 25 per cent is distributed to other workers in the "zone of cooperation" whose work is such that B's cannot be determined.

The Haynes Manit Plan. A "manit" is defined as "four-fifths of the amount of work that a normal worker can turn out in a minute of time without overexertion." It can be determined only by careful time study. All work is evaluated in terms of the number of manits. Workers are paid in full for the number of manits they complete.

BONUS-PAYMENT PLANS

In addition to regular wages, some companies share economic good fortune with their employees by paying bonuses. Such bonus payments are usually based on the selling price of the product, or the amount of production, or the profits made by the company.

Bonus Payment Based on Selling Price of Product. A paper-products company and its union stated in their contract for 1940 that when the average selling prices of the company's several products varied 5 per cent up or down from those of June 1, there would be a corresponding adjustment of wages. A zinc company agreed with its union to give a bonus of 2½ cents per hour so long as the price of zinc was between the range of \$7.25 and \$7.75 per hundred pounds, 5 cents per hour when the price ranged between \$7.75 and \$8.25 per hundred pounds, and 7½ cents per hour when the price was between \$8.25 and \$8.75 per hundred pounds. Higher prices would be the subject of further wage negotiations. A copper-mining company and its union agreed that wage rates would be related to the selling of electrolytic copper as follows:

Price of Copper per Pound	Wage Rates per Day
\$0.09 or less	Base rates only
\$0.09 to \$0.09¾	Base rates plus \$0.25
\$0.09¾ to \$0.11½	Base rates plus \$0.50
\$0.11½ to \$0.13	Base rates plus \$0.75

Higher prices than those stated would be reflected in wage increases at the rate of \$0.25 per day for each \$.01½ per pound rise in the price of copper.[9]

The selling price of the processed product is the basis for various forms of sliding wage scales used in many of the European countries. Steelworkers of England were paid on this basis for many years. Many industries in Sweden pay their employees according to the selling price of the products produced. In general, however, American labor unions have opposed all wage-payment plans which make the amount of wages unpredictable. Workmen like to know exactly how much they are going to get on payday.

Bonus Payment Based on Company Profits. A large chemical company and its union have an agreement that, in addition to fixed base wages, each employee and foreman will receive for every hour worked during the year his proportionate share of a percentage of company profits. The percentage is determined as follows:

0% of the first \$120,000 profits.
3% of the second \$120,000 or any part thereof.
6% of the third \$120,000 or any part thereof.
9% of the fourth \$120,000 or any part thereof.
12% of any excess over \$480,000.

A metal-products company made the following agreement with its union:

> First, any dividend paid to stockholders up to an amount equal to six per cent per annum upon the current book value of the common stock shall be considered as wages of capital.

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[9] The above data are taken from *Problems in Wage Adjustment*, Studies in Personnel Policy, No. 33.

Second, any profits that are distributed over and above the regular wages of employees and the six per cent wages of capital shall be shared by paying to all eligible employees the same per cent on their total earnings for the year as is paid to stockholders over and above six per cent on the book value of the common stock.

An electric company agreed to distribute 15 per cent of *all* profits (after taxes and preferred-stock dividends were paid) to factory workers (exclusive of foremen and assistant foremen) in proportion to the total yearly wages of each. Foremen, assistant foremen, and office employees received 7½ per cent of all profits on the same basis.[10]

Profit-sharing plans have been largely discontinued in American industry and business because of four basic reasons (1) Employees are unable to understand and appreciate the complexity of profit calculations. Consequently, (2) such plans have failed to motivate greater employee efficiency. (3) Often there are no profits to share and employee discontent is increased. (4) Organized labor has consistently opposed profit sharing in preference for straight wage increases.

Bonus Payments Based on the Volume of Production. A machine-tool manufacturer paid a wage bonus starting at 3 cents per hour for increased production above that of a specified month. Some months the increased production resulted in bonus payments as much as 9.4 cents per hour. A steel-casting company agreed with its union that when the production of the plant exceeded 65 per cent of capacity, bonus payment would be made on the following basis:

Per Cent of Capacity	Per Cent Increase in Wages
65–70	2
70–75	3
75–80	4
80–85	5
85–90	6
90–95	8
Over 95	10

Bonus Payments Based on Cost of Living. The financial structure of every country is handicapped by the fluctuating value of its monetary units. The value of the dollar, for example, varies from year to year and even from month to month. A pay envelope that is adequate to buy a "decent standard of living" at one time is entirely inadequate at an-

[10] *Ibid.*

other time. Over a period of years, the general trend of the dollar's value is downward. During depressions, however, it recovers some of its lost value. The problem of stabilizing the value of money is a complicated one and its discussion is inappropriate in this book. Nevertheless, it must be recognized as one of the major causes of industrial unrest and conflict.

While wage rates geared to the cost of living were used in England during and following the First World War, they have never been popular in America. In 1936, the General Electric Company adopted such a plan for all hourly paid employees and all salaried employees receiving $3,000 per year or less. The cost-of-living index compiled by the U.S. Department of Labor was taken as the determiner of adjustments. As it rose above 80, wages increased 1 per cent for each index point up to a maximum of 10. As the index went down, there was a downward adjustment of wages until the base of 80 was reached. No wage reduction occurred below that level. Other companies paying extra wages to compensate for increased cost of living vary from the above pattern only in minor details. A machine company agreed with its union that "whenever the cost-of-living index registers a change equal to or exceeding three points, a corresponding percentage in wages will be granted by the company." A manufacturing company agreed that a cost-of-living bonus of 5 per cent will be paid for each 5 per cent increase in the cost-of-living index for the area in which the company is located.

It should be emphasized that, regardless of the method used in the payment of wages and salaries, it is fundamentally important for the employee to *understand* the method and be able to calculate his own wages. If he figures that he should receive $47.50 in a pay envelope and then finds that there is only $47, he is likely to be disgruntled. Even if he receives more than he expected, he is likely to condemn such a pay system. The method of wage calculation should be simple enough to be understood by the workman, at least with proper explanation. He should be able to calculate his own wages with instruction.

Furthermore, the pay method should fit the situation. Good quality cannot be produced by piece-rate payment. On the other hand, production on monotonous jobs can usually be increased by the use of bonus and piece-rate methods of payment. The most effective method of wage payment in a particular situation can be determined only by careful analysis and research.

WORKER EVALUATION

The procedure of evaluating men is variously referred to as merit rating, performance rating, proficiency rating, service rating, worker appraisal, personnel review, and progress reports. The term "merit rating" is more generally used, and we shall follow that precedent in this discussion. Merit rating is the determination of the worth of an individual to an organization without regard to the worth of the work he performs. Just as job evaluation is independent of a man's worth, so is man evaluation independent of a job's worth.

Employers have always rated men, though it has usually been unsystematic and slipshod. Whenever an employee is promoted or demoted or transferred or fired, he has been merit rated. Unfortunately, such ratings are often random, haphazard, prejudiced, and indefensible. In recent years, the more progressive companies have attempted to systematize and standardize the merit ratings of their employees. The following pages review some of these attempts.

Methods of Merit Rating

There are two general methods of merit rating—the over-all or man-as-a-whole method and the analytical method. As often used, they are both low in reliability but better than no method at all. Like job evaluation, their worth depends upon the care and skill of those who perform the ratings.

There is considerable research justification for using an over-all method of merit rating rather than an analytical method. Tiffin[11] made a factor analysis study in which he used a rating scale of 12 items, or traits. He found that the intercorrelations were very high indicating that there was some factor common to all of them. After further statistical analysis, he was able to identify this factor as "ability to do the present job." A second factor appeared which was related to accuracy, versatility, and knowledge of the job. This was named "quality of performance on the job." However, this was a very weak factor as compared with the first one. The implication of the study was that if men are rated on but one trait—ability to do the present job—there will be but little sacrifice in either reliability or accuracy.

While over-all methods of merit rating are adequate for determining a man's wages, they are very inadequate for counseling him on why he is not rated higher. Men want to know in what respects they are superior, average, and inferior. A man cannot improve unless he knows what his points of weakness are. For this reason, methods of merit rating have been developed which analyze men and evaluate them on traits which are considered to be of worth to the company.

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[11] Ewart, E., Seashore, S. E., and Tiffin, J., A Factor Analysis of an Industrial Merit Rating Scale, *J. Appl. Psychol.*, 1941, 25, 481–486.

Rank-order Rating. Rank-order rating of men is a procedure of arranging them in order of their personal worth to the company. Table 6–1 is a typical form used for this purpose. It has been found to be satisfactory with small groups, especially when it is done by several supervisors and followed by a conference on disagreements. Like all other methods of merit rating, careful training of raters is a prerequisite for its success.

Table 6–1. Form for Ranking Workmen on Over-all Value to the Company

Rating Form

Rater__________ Department__________ Date__________

Instructions: List the employees under your supervision in order of their personal worth to the company regardless of the wages or salary they now receive. Put at the head of the list the man who in your opinion would be the most difficult to replace. Consider all the traits and characteristics which make up a "good employee." Then, put at the bottom of the list the man who in your opinion would be the most easily replaced, and perhaps should be replaced. Then, choose a man who is about halfway between these extremes. Fill in the names of all others in proper order. Do not rate men on the basis of the importance of the work they perform, but on the basis of how well they do it. You are rating men, not jobs.

1. __________
2. __________
3. __________
4. __________
5. __________
6. __________
7. __________
8. __________
9. __________
10. __________
11. __________
12. __________
13. __________
14. __________
15. __________
16. __________
17. __________
18. __________
19. __________
20. __________

Man-to-man Comparison. Some companies rate men by comparing them with every other man in the department. Every employee is rated as superior, inferior, or equal to every other employee. Table 6–2 illustrates how one company conducted such a man-to-man comparison rating procedure. Like the rank-order method, this method is more effective with small groups of employees. Also, its value depends on how

TABLE 6–2. FORM FOR COMPARING WORKMEN WITH EACH OTHER ON OVER-ALL VALUE TO THE COMPANY

Rating Form

Rater________________ Department________________ Date____________

The men under your supervision are listed in the form below. Compare each man listed in the vertical column at the left with each man listed horizontally across the top. If he is superior to the man listed at the top in over-all worth to the company, put a plus sign in the square below. If he is inferior to him, put a minus sign in the square. If you think the two are equal in over-all worth to the company, put an equals mark.

	Bill Smith	Swede Carlson	Jack Green	Hank Smith	Dick Melby	Tom Carter	Nick Wilson	O. M. Black	Ed Thomas
John Jones									
Bill Smith									
Swede Carlson									
Jack Green									
Hank Smith									
Dick Melby									
Tom Carter									
Nick Wilson									
O. M. Black									

well the raters are trained in rating and how well they understand the meaning of "over-all worth to the company."

One of the oldest man-to-man rating methods was developed by Scott[12] during the First World War for selecting candidates for officer's training school. The method as originally developed was analytical in nature (that is, men were compared on separate traits) but has often been adapted for use in over-all man classification. The rater must prepare his own master scale by selecting individuals from his own acquaintances who just fit the level of merit under each trait. For example, if the trait is "leadership" the rater selects an acquaintance who, in the rater's opinion, possesses the highest qualifications in leadership.

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[12] Scott, W. D., *et al., Personnel Management,* p. 216, McGraw-Hill Book Company, Inc., New York, 1950.

He then writes the name of this acquaintance on his master sheet opposite this degree (see Table 6–3). Next, he selects an acquaintance who has the lowest qualifications in leadership and writes his name opposite this degree on his master sheet. The same procedure is followed for the other three levels and for all other traits that may be included on the scale. The names of acquaintances who may fit the various degrees on other traits will, of course, be different.

TABLE 6–3. THE TRAIT "LEADERSHIP" (FROM THE SCOTT MAN-TO-MAN RATING SCALE)

III. *Leadership.* Initiative, force, self-reliance, decisiveness, tact, ability to inspire men and to command their obedience, loyalty, and cooperation.

Highest	*John Jones*	15 points
High	*William Brown*	12 points
Middle	*Thomas Green*	9 points
Low	*Samuel Smith*	6 points
Lowest	*James White*	3 points

When the scale is completed, men to be rated are then compared directly with the men whose names appear on the master scale. Each degree, or level, has a numerical value and a score is obtained. Obviously, the method is cumbersome and not easily adaptable for industrial use.

Scale Method. In this method of merit rating, those human traits which are considered important in the work being performed are selected and varied amounts or degrees of each are scaled from low or little to much or high. This is usually printed on a form, illustrated in Table 6–4, on which the rater indicates the amount of a trait he believes a workman to possess. Sometimes weights are given to these amounts and a numerical score of a workman's rating is computed. (The technique is similar to that of the point system in job evaluation.)

Check-list Method. Some firms merit rate workmen by having supervisors check such statements, on a list of prepared statements, as may fit the workman being rated. For example, on a list of 20 statements ranging from good to bad, the supervisor is asked to check the three which most nearly fit the workman being rated. Sometimes the supervisor is asked to indicate the extent to which each statement on a list fits a workman being rated. Such a list is illustrated in Table 6–5. The items are often weighted so that a numerical score is obtained for each workman. However, check lists are more rarely used for merit rating in industry than scale methods.

TABLE 6–4. SCALE FOR RATING WORKMEN

Workman's name____________________Department__________Date__________

Check opposite each trait the degree which most accurately fits this workman.

Trait	Degree			
	Superior	Above average	Ordinary	Unsatisfactory
Knowledge of job	( ) Thorough and complete	( ) Good but not the best	( ) Adequate	( ) Superficial—not adequate
Job performance	( ) Excellent—one of best	( ) Very good	( ) Satisfactory	( ) Slow and inaccurate
Judgment	( ) Sound and practical	( ) Occasional error in judgment	( ) Decisions uncertain	( ) Generally wrong in judgment
Initiative	( ) Makes his job bigger	( ) Very alert	( ) Follows directions adequately	( ) Must be carefully directed
Attitude toward responsibility	( ) Seeks it	( ) Will accept it	( ) Tries to avoid it	( ) Fails when given responsibility
Dependability	( ) Never fails his obligations	( ) Occasionally slips	( ) Must be checked	( ) Usually fails his obligations
Cooperation	( ) Helps others at every opportunity	( ) Good team worker	( ) Fair team worker	( ) Cannot work with others
Leadership	( ) Others seek to follow him	( ) Attains some influence	( ) Rarely influences others	( ) Has no influence on others

TABLE 6–5. CHECK LIST FOR MERIT RATING WORKMAN

Name____________________ Department____________ Date__________

Item	A	B	C	D	E
1. On time for work	( )	( )	( )	( )	( )
2. Gets his work done rapidly	( )	( )	( )	( )	( )
3. Works steadily	( )	( )	( )	( )	( )
4. Turns out the required amount of work	( )	( )	( )	( )	( )
5. Wastes time on the job	( )	( )	( )	( )	( )
6. Shirks his share of work	( )	( )	( )	( )	( )
7. Follows instructions carefully and accurately	( )	( )	( )	( )	( )
8. Turns out an exceptionally large amount of work	( )	( )	( )	( )	( )
9. Finishes all details of the work	( )	( )	( )	( )	( )
10. Works well without supervision	( )	( )	( )	( )	( )
11. Uses all safety devices	( )	( )	( )	( )	( )
12. Cooperates effectively with others	( )	( )	( )	( )	( )
13. Stirs up trouble among the men	( )	( )	( )	( )	( )
14. Use of intoxicants hurts his work	( )	( )	( )	( )	( )
15. Wastes fuel, lubricants, and other supplies	( )	( )	( )	( )	( )
16. Plans and arranges his work effectively	( )	( )	( )	( )	( )
17. On lookout for ways to do job better	( )	( )	( )	( )	( )
18. Given most difficult assignment in his group	( )	( )	( )	( )	( )
19. Operates machinery and equipment with care and skill	( )	( )	( )	( )	( )
20. Keeps tools, equipment, and machinery in good working condition	( )	( )	( )	( )	( )

A. Mark when item is completely and entirely characteristic of employee's work.

B. Mark when item is almost but not entirely characteristic of employee's work.

C. Mark when the item describes the employee's work to a large extent but when there are important exceptions.

D. Mark when the item is characteristic of the employee's work only now and then.

E. Mark when the item is only rarely or never characteristic of the employee's work.

RELIABILITY OF MERIT RATING

Studies of the reliability of the methods of merit rating just described indicate that they are all unsatisfactory as a form of measurement. Tiffin[13] reports a study of a 12-item rating scale used to merit rate 4,500 employees. The correlations between pairs of raters are given in Table 6–6. Note that they are all far below the minimum of .80 usually required for psychological measurement. An old study by Slawson[14] showed reliability correlations of rating personality traits to be correspondingly low. All except one were below .50. On the other hand,

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[13] Tiffin J., *Industrial Psychology,* p. 348, Prentice-Hall, Inc., New York, 1948.

[14] Slawson, J., The Reliability of Judgments of Personal Traits, *J. Appl. Psychol.,* 1922, 6, 161–171.

TABLE 6-6. RELIABILITY COEFFICIENTS IN A MERIT-RATING SCALE

Trait	r
Safety	.35
Knowledge of job	.46
Versatility	.47
Accuracy	.45
Productivity	.46
Over-all job performance	.46
Industriousness	.47
Initiative	.48
Judgment	.45
Cooperation	.37
Personality	.39
Health	.36
Total scale	.55

Shuey[15] found that reliability coefficients for the traits on a personality scale ranged from .57 to .70. He estimated that the use of 20 raters would give "reliability adequate to justify individual differentiation."

Low reliability in merit rating (as indicated by disagreement between raters) is caused by a number of conditions. First, raters differ in the distribution of their ratings. One may rate too many at the upper end of the scale (called the leniency error), another may rate too many in the middle of the scale (called the error of central tendency), while another may rate too many at the lower end of the scale (called the error of acrimony). These errors can be corrected by what Tiffin[16] calls the "forced distribution system." Raters are instructed to place a specified percentage of their workmen in each grade or level of performance for each trait. If there are five grades the distribution required may be as follows:

Lowest, 10% . . . . . Next, 20% . . . . . Middle, 40% . . . . . Next, 20% . . . . . Highest, 10%

Second, some raters tend to rate a workman high or low on all traits because he is obviously high or low on a certain trait. (This is called the "halo error.") The remedy for this is horizontal rather than vertical rating. Stevens and Wonderlic[17] suggested long ago that a rater should rate all his men on one trait at a time. It is sometimes advisable after rating a group of men on one trait to allow an interval of a week or 10 days before rating them on the next trait.

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[15] Shuey, A. M., The Reliability of the Wilke Personality Rating Scale, *J. Educ. Psychol.*, 1943, 34, 373–377.

[16] Tiffin, *op. cit.*, p. 325.

[17] Stevens, S. N., and Wonderlic, E. F., An Effective Revision of the Rating Technique, *Person. J.*, 1934, 13, 125–134.

Third, raters are often improperly trained in merit rating. Each rater has a different understanding of the traits used and of the grades or levels under each. Too often raters do not take the assignment seriously. Their ratings are superficial and do not represent mature judgment. One executive is quoted by the National Industrial Conference Board[18] as follows:

> I would say that no program is too difficult, nor should any reasonable expenditure be questioned, if it will bring about a thorough understanding of a rating plan on the part of the supervisors who will be concerned with it. Meetings should be held, charts should be shown, typical and fictitious cases should be used to illustrate how ratings are made and afterwards used. The plant manager should, by all means, give his personal attention to showing that he is for the idea and wants its religiously followed out. If these things are not done, a good deal of the plan is practically junked before it ever gets into motion.

After the training program is completed, it is well to merit rate the first time for practice. Use of the ratings should be postponed until the second time they are made. Adequate training of merit raters cannot be overemphasized.

Fourth, ratings are often inaccurate due to inadequate information about a man and/or superficial consideration of information already known. The remedy for this is a conference of raters on their disagreements in rating. Only one trait should be discussed at each conference. This permits more mature evaluation of men in light of comments made by the raters with different points of view. These conferences should not result in jury rating, however. All ratings should continue to be individual. Ghiselli and Brown[19] report a study by Rusmore in which jury rating was found to be inferior to individual rating. The correlation between pooled independent ratings and job performance was .84, while that between jury rating and job performance was only .77. Conferences between raters which take place after they have made individual preliminary ratings and which are followed by individual revisions do not constitute jury rating. Conferences tend to eliminate uncritical judgments which, when pooled, count just as much as immature ratings.

Fifth, the reliability of merit rating is increased if objective traits are rated only by objective data. It is unwise to rate quantity of production by judgment if it can be rated more accurately by consulting production records. This is frequently true also of quality of production. For example, intelligence can be more accurately rated by administering intelligence tests than by supervisor judgment. Any trait that can be more accurately rated by some other means should not be determined by judgment. Merit rating by judgment should be reserved for those traits that cannot be determined in any other way. When horizontal rating (one trait at a time) is used, as suggested above, only those trait sheets that require judgment need be handed out to the raters. Table 6–7 illustrates how one company prepared a trait sheet for merit rating by judgment.

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[18] Employee Rating, *Studies in Personnel Policy*, No. 39.

[19] Ghiselli, E. E., and Brown, C. W., *Personnel and Industrial Psychology*, p. 109, McGraw-Hill Book Company, Inc., New York, 1948.

TABLE 6–7. TRAIT SHEET FOR HORIZONTAL MERIT RATING

Rater's name______________________ Department______________ Date______________

You are asked to classify the men in your department, listed on the enclosed sheet, according to *dependability*. In the extreme right column write the name of the man who is most dependable; then in the extreme left column, write the name of the man who is least dependable; then write the names of two men who are most typical of the two average columns. Compare the rest of your men with these four and write their names in the appropriate column. Be sure that 10 per cent of your men are in the "high" group, 10 per cent in the "low" group, and the rest equally divided between the other two groups.

III. *Dependability*. How does a man compare with other men in reliability? Does he require more or less supervision than the average because he is trustworthy? To what extend can you depend on him?

Low (10%)	Low average (40%)	High average (40%)	High (10%)

If these five suggestions for increasing the reliability of merit rating are followed, the coefficient of reliability will be above the .80 usually required.

SUMMARY

The wages men receive for their labor depend on the economic conditions of the country, the production efficiency of the company, and the profit demands of the owners. The wealth created by labor is returned to labor in only fractional amount. Many methods are used to give workmen this fraction. They may be paid for the *time* spent at work, or for the *amount of produce* processed, or for the *quality of product* processed, or according to other factors, such as selling price, or amount of profit, or cost of living. Each wage-payment plan has certain values and certain limitations which make it appropriate for certain situations and inappropriate for certain others.

Workmen themselves are evaluated by being ranked in order of merit, compared with each other individually, graded according to a scale of values, and identified with certain statements of merit (or incompetence). Whatever method is used to rate or evaluate intangible merits of workmen is likely to be inaccurate. This reliability can be raised, however, by requiring raters to distribute their ratings in all levels of merit, to rate "horizontally" (all workmen on one trait rather than one workman on all traits), to study both the rating scale and the men to be rated more carefully, to confer with each other about all disagreements *after* independent ratings, and to rate workmen on only those traits that cannot be determined more objectively in any other manner.

RECOMMENDED READINGS

BELLOWS, R. M.: *Psychology of Personnel*, Chap. 11, Prentice-Hall, Inc., New York, 1949.

GHISELLI, E. E., and BROWN, C. W.: *Personnel and Industrial Psychology*, Chaps. 3–4, McGraw-Hill Book Company, Inc., New York, 1948.

National Industrial Conference Board: *Employee Rating, Studies in Personnel Policy*, No. 39, New York, 1942, also No. 8, 1938.

PROBST, J. B.: *Measuring and Rating Employee Value*, The Ronald Press Company, New York, 1947.

SMYTH, R. C., and MURPHY, M. J.: *Job Evaluation and Employee Rating*, McGraw-Hill Book Company, Inc., New York, 1946.

TIFFIN, J.: *Industrial Psychology*, Chap. 10, Prentice-Hall, Inc., New York, 1947.

———: Merit Rating: Its Validity and Techniques, *American Management Association, Personnel Series*, No. 100, 20–22.

ZERGA, J. E.: Developing an Industrial Merit Rating Scale, *J. Appl. Psychol.*, 1943, **27**, 190–195.

Chapter 7

WAGES AND JOB EVALUATION

Methods of Job Evaluation
  The Job Ranking System
  The Job Grading System
  The Ready-made Point System
  The Money-value System
  The Custom-made Point System
    Start with a Job Evaluation Committee
    Analyze All Jobs
    Select Key Jobs
    Discover Job Factors
    Weight Job Factors in Per Cent of Total Wage
    Construct a Table of Factor Levels, or Degrees, and Their Weights
    Evaluate All Jobs That Have Been Analyzed
Validity of Job Evaluation
Reliability of Job Evaluation
Job Evaluation and Wage Rates
Summary

Regardless of the factors which affect the amount of money available for wage payment, and regardless of the method used in paying wages, the value or worth of jobs must be determined. This can be done by following the community custom of wage rates for apparently similar jobs, with consequent overpay for some jobs and underpay for others, or it can be done in a more careful and analytical way known as *job evaluation.*

Job evaluation is a procedure of comparing jobs with each other and rating them with all significant factors taken into consideration. It has nothing to do with the efficiency of the workman on the job, or with the profits made by the company, or with the economic conditions of the country. Rather it is an organized method of determining whether a job is worth more than, less than, or the same as, other jobs. This relative comparison is stated in metrical terms, usually points. For example, one job may be evaluated at 260 points, another at 240 points, and another at 200 points. When these point values are translated into money values, the jobs may pay \$1.15 per hour, \$1.10 per hour, and \$1.05 per hour respectively. However, the translation of job evaluation values into monetary values, or wage rates, is not a part of job evaluation per se. Wage setting is what job evaluation is used for, but this is usually done by another individual than the job evaluator and often even in another department.

The first step in job evaluation is a careful study of the job. Job analysis is a prerequisite. Even if the job evaluator has worked at the job himself, it is necessary for him to write out a job analysis. This may be more brief than that described in Chap. 2 of this book. In fact, the usual job analysis used in job evaluation covers only those factors which are actually used in the evaluation. A typical job analysis used in the point system of job evaluation is illustrated in Table 7–1. (This

TABLE 7–1. JOB ANALYSIS FOR JOB EVALUATION

Job name *Shear Operator (Pels)* DOT Code 6-88.644

Job description: Set up and operate large Pels No. 70 shear machine

Factors	Rating	Basis of rating
Education	2 (28)	Must be able to use simple arithmetic; work from specification sheets; use scale and calipers; equivalent to 2 years high school
Experience	2 (44)	Up to 1 year to learn shear setup and operation
Initiative and ingenuity	3 (42)	Steel stock varies in size, shape, and hardness; must set up and adjust machine for proper operation, operate machine, and supervise work of helpers
Physical demand	3 (30)	Sustained physical effort necessary in making setups, operating machine, and handling bar stock (bars are fed into machine by mechanical table)
Mental and visual demand	3 (15)	Continuous attention necessary in operating machine and making adjustments
Responsibility of equipment or process	3 (15)	Machine is equipped with overload safety device; carelessness may cause breakage of blade; probable loss not over $100
Responsibility for material or product	3 (15)	Careless operation may shear pieces too long or too short; loss probably not over $250
Responsibility for safety of others	3 (15)	Standard safety precautions necessary to avoid injury to helpers, especially when making setups and adjustments
Responsibility for work of others	2 (10)	Must instruct and direct two helpers
Working conditions	4 (40)	Machine is located near steam hammers; continuously exposed to fumes, dirt, noise, vibration, and temperature changes
Unavoidable hazards	3 (15)	May lose fingers in shear; may fall while making adjustments; may crush hands while handling material
Total	269	Labor grade 6

is taken without modification from the files of a large steel company.) While a job analysis should be as detailed as that recommended in Chap. 2, it is often more brief even than the one given in Table 7–1 and is too often omitted entirely.

METHODS OF JOB EVALUATION

There are five different methods of job evaluation: job ranking, job grading, the ready-made point system, the money-value system, and the custom-made point system.

The Job Ranking System

Job ranking is merely a procedure of listing jobs, usually in a single department, in order of their worth to the company. This may be done by a committee of supervisors or by imported experts. The usual procedure is to write job titles, and perhaps brief definitions, on 3- by 5-in. cards. Each judge then arranges these in order according to his estimate of their importance. It is usually recommended that the highest, the lowest, and the average be determined first and the others filled in by comparison. These rankings are then summarized and disagreements are discussed by members of the committee. Often judges change their rankings because of facts brought out in discussion which they had failed to evaluate properly. When the final ranking is made, the jobs are catalogued in order of their importance, and pay rates are adjusted accordingly. Table 7–2 lists the jobs in a certain department as they were finally ranked by an evaluation committee.

Table 7–2. Jobs Ranked According to Importance

Rank	Job
1	Hammersmith—Bradley A
2	Board hammerman
3	Upsetter operator
4	Bulldozer operator
5	Hammersmith—Bradley B
6	Hot trim-press operator
7	Blacksmith B
8	Crane-hitch man
9	Heater—board hammer
10	Blacksmith helper

Job ranking is better than no job evaluation at all, but it is not as satisfactory as some of the other methods discussed below. It is likely to be superficial and consequently inaccurate.

THE JOB GRADING SYSTEM

Job grading (sometimes called "job zoning" or "job classification") is a procedure of placing jobs in previously determined grades distinguished by varying levels of difficulty and responsibility. For example, in the Westinghouse Electric Corporation the salaried or "white-collar" jobs in the works division of the company are all classified in seven groups: policy, administrative, executive, creative (professional), interpretative, skilled, and unskilled. Each group is carefully defined and each job, after careful analysis, is included in the appropriate group. This "reflects the best judgment of all who know about that position."

The principal objection to job grading, as with job ranking, is that it is likely to be superficial. Jobs can be placed in grades without careful analysis and without critical evaluation. The method is so simple that the temptation to have it done by untrained evaluators is very great. Some companies, like Westinghouse Electric, have used it in certain divisions with care and success. However, it has often been misused.

THE READY-MADE POINT SYSTEM

The ranking and grading methods of job evaluation just described, are "over-all" or "job-as-a-whole" methods. That is, the evaluation procedure does not break the job down into aspects. The three methods described in the following pages may be called "analytical" or "factor" methods. Jobs are broken down and evaluated on the basis of carefully defined aspects or factors. The evaluation of the whole job is the sum of the evaluation of its various aspects or factors. These vary somewhat with the particular method used but include such factors as working conditions, physical hazards, experience, responsibilities, etc. These factors may be determined by the judgment of those in authority, or by careful analysis of the jobs to be evaluated, or by a statistical procedure known as "factor analysis," or by adopting a system with factors already determined. Whatever method of factor determination is used, the next step is to weight those factors. This may be done by any of the four methods just mentioned, *i.e.*, by judgment, by job analysis, by statistical analysis, or by the adoption of predetermined weights.

The point system of job evaluation uses the latter method for determining both factors and their weights. That is, it is a ready-made system of job evaluation which is used in situations for which it was not specifically designed but for which it at least seems to be fairly appropriate. For example, the system of job evaluation illustrated in Table 7–1 was developed by the National Electrical Manufacturers Association. (These factors and values are also used by the National Metal Trades Association.) The 11 factors (in Column 1) and the point values (in Column 2) were determined in some manner unknown to this author and unknown to the company that used it. It was a ready-made system which seemed to be fairly appropriate for the jobs that were to be evaluated. The point value of each degree for each factor is given in Table 7–3. Each factor and each degree is carefully defined in a job-evaluator's manual. Also, typical job analyses and evaluations (sometimes called "bench-mark" jobs) similar to the one in Table 7–1 are given in another manual.

TABLE 7–3. FACTOR AND DEGREE VALUES IN THE JOB EVALUATION SYSTEM OF THE NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION AND THE NATIONAL METAL TRADES ASSOCIATION

Factor	Degree				
	1st	2d	3d	4th	5th
Skill:					
Education	14	28	42	56	70
Experience	22	44	66	88	110
Initiative and ingenuity	14	28	42	56	70
Effort:					
Physical demand	10	20	30	40	50
Mental or visual demand	5	10	15	20	25
Responsibility:					
Equipment or process	5	10	15	20	25
Material or product	5	10	15	20	25
Safety of others	5	10	15	20	25
Work of others	5	10	15	20	25
Job conditions:					
Working conditions	10	20	30	40	50
Unavoidable hazards	5	10	15	20	25

Some point systems of job evaluation weigh all factors equally. The 10 factors used in the Job Rating Scale in Table 7–4 are all of equal weight at each degree level.[1] A comparison of the weights given to factor groups by five different job evaluation systems is shown in Table 7–5. Note that all of them give considerably more weight to the skill factors than to any of the other three combinations. A list of typical

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[1] This is the form used to evaluate each job. Note that it contains all factor and degree definitions, rather than a summary job analysis as shown in Table 7–1.

TABLE 7–4. JOB

Date____________________Job title________

Factors		
	0	2
Education—this is the formal preparation required to perform the job; need not be obtained in school, but assumes school standards in this rating	*Grammar school.* Office jobs—seldom applicable. Factory jobs—ordinary labor or equivalent	*2-year high school.* Office jobs—about minimum. Factory jobs—leader of small gang; simple figuring; semitrade
Previous experience—on same or related work; this is the practical preparation required and includes essential experience on preceding jobs	*None.* Office jobs—possibly messenger. Factory jobs—strictly common labor	*1-year.* Office jobs—minor clerical or equivalent. Factory jobs—important labor
Training time on job—time to comprehend all aspects of the job; include time for understudying any other job which is part of duties	*Very little*	*1 month*
Physical or mental fatigue—due to requirements or working conditions; this is "wear and tear" resulting from the work	*Very light.* For simplest exercise of mind or body; some very routine job	*Moderate.* Where occupant is seldom extended; many ordinary routine jobs
Details—to organize and handle outside of routine or explicit instructions	*Very few.* Simplest labor jobs or equivalent take this rating	*Recognized factor.* For jobs where quality is of enough importance to become a factor
Quality requirements—extent job demands care and skill; weigh "care," "skill," "accuracy," and "frequency of application"	*Very few.* Simplest labor jobs or equivalent take this rating	*Recognized factor.* For jobs where quality is of enough importance to become a factor
Resourcefulness—extent job demands initiative and ingenuity on problems outside the control of routine or supervisions	*Very little.* For jobs where little or no resourcefulness is required	*Occasional.* For jobs particularly well routinized or directed
Versatility—number of major skills or operations required; weigh number and quality of talents required	None	One semiskill
Cooperation and personality—need for tact and agreeableness in working with others; allow for outside contacts	*Very little.* For a job where occupant works alone and contacts are unimportant	*Below average.* For ordinary rank-and-file job where occupants merely work together in groups
Responsibility—relation of job to company assets and success of business; base on reasonable assumption and include both tangible and intangible effect on product, equipment, and good will; consider checks and supervision	*No direct relation.* For jobs that involve practically no loss or gain to the company	*Very little relation.* For jobs where effect of gain or loss is estimated not to exceed $1,000 or its equivalent

RATING SCALE

________________Rated by______________________

Degrees			
4	6	8	10
High school graduate. Office jobs—ordinary clerical and typing. Factory jobs—better clerical supervisory and trade	*High school plus business or vocational.* Office jobs—better clerical bookkeeping, or secretary. Factory jobs—department head and foreman	*College graduate.* Office or factory. Major supervision, engineering	*College graduate plus technical.* Office or factory. All jobs where high level training is necessary
2 years. Office jobs—average clerical or stenographer. Factory jobs—Process or machine tending	*3 years.* Office jobs—better clerical or stenographer. Factory jobs—some trades. Minimum for leaders	*4 years.* Office jobs—secretary with responsibilities. Factory jobs—trade and foremen	*5 years or more.* Office and factory—important supervisory and technical
3 months	*6 months*	*12 months*	*18 months or more*
Average. For normal activity at usual type of work under good working conditions	*Active.* For busy jobs that keep occupant on his toes most of the time	*Strenuous.* For usually busy or exacting jobs where endurance is taxed frequently	*Extreme.* Reserve for the most severe jobs
Substantial number. About right for job on varied work—typical clerk or leader of small gang	*Important.* For jobs where details outside the control of routine or supervision merit	*Very important.* For jobs where details constitute a big problem—should be important detail	*Extreme.* Reserve for important jobs with a mass of details that cannot be routinized
Ordinary. Office jobs—about right for the average. Factory jobs—many process and machine tending	*Important.* Office and factory jobs requiring special care and precision	*Very important.* For jobs which require undivided attention and where failure would be a serious matter	*Exceptional.* Reserve for the most exacting jobs—great concentration plus high skill
Frequent. For jobs requiring independent thinking and action possibly once a week	*Daily problems.* For jobs requiring independent thinking and action almost daily	*Great deal of independent thinking.* About right for many of the high grade supervisory jobs	*New problem constantly.* Reserve for jobs where it is necessary to face and decide important matters constantly
Two semiskills	One semiskill and one skill	Two skills	More than two skills
Average. For all jobs where occupant must contact others	*Above average.* For important contacting jobs where factor held should get recognition	*Very important.* For major contacting positions with customers	*Exceptional.* Reserve for jobs where personality and ability are primary qualifications
Moderate. For jobs where effect of gain or loss is estimated not to exceed $3,000 or its equivalent	*Important.* For jobs where effect of gain or loss is estimated not to exceed $10,000 or its equivalent	*Very important.* For jobs where effect of gain or loss is estimated not to exceed $25,000 or its equivalent	*Directly affects success of business.* Reserve for jobs where effect of gain or loss is estimated to reach $50,000 or its equivalent

TABLE 7–5. PER CENT OF POINT VALUES GIVEN TO VARIOUS JOB-FACTOR COMBINATIONS BY FIVE DIFFERENT POINT SYSTEMS OF JOB EVALUATION

Factor combination	Point systems					
	I	II	III	IV	V	Average
Skill (education, experience, initiative and ingenuity, training time, etc.)	62.5	45	60.3	50	50	53.6
Effort (mental, physical, visual, etc.)	12.5	16	22.2	15	18	16.7
Responsibility (tools and equipment, safety of others, work of others, materials, processing, reports and records, confidential information, etc.)	12.5	24	13.8	20	16	17.3
Working conditions (hazards, dirt, fumes, weather changes, excessive heat, etc.)	12.5	15	3.7	15	11	11.4

jobs in a large steel plant and their point value for each factor is shown in Table 7–6. The total points determine the wage value of each job.

The ready-made point systems of job evaluation have both advantages and disadvantages—most of them centering around the fact that they are ready-made and immediately available for use. In places where the jobs are closely comparable to those for which the particular system was designed, that system can be used successfully. For example, the NEMA system (see Table 7–3) is appropriate for use in any plant having jobs similar to those in an electrical manufacturing plant. With modifications only in the evaluator's manuals, the same system has been effectively used by the National Metal Trades Association in steel mills and steel-fabricating plants. On the other hand, ready-made point systems are too frequently used to evaluate jobs that are so different from those for which the system was designed that only unfair evaluations can result. The NEMA system is entirely inappropriate for evaluating most of the jobs in a department store or even in the clerical department of an electrical manufacturing plant.

THE MONEY-VALUE SYSTEM

The so-called "factor comparison" method developed by Eugene Benge,[2] is a step toward fitting job evaluation to the specific needs of the situation in which it is used. However, the title does not distinguish it from point systems. In actual practice, all systems of job evaluation

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[2] See Benge, E. J., *et al.*, *Manual of Job Evaluation*, Harper & Brothers, New York, 1941.

Table 7–6. Typical Job Evaluation from the Files of a Steel Company

Factor	Job*											
	1	2	3	4	5	6	7	8	9	10	11	12
Responsibilities:												
Safety of others	8	16	14	9	3	32	38	32	17	9	7	7
Supervision	10	10	4	4	0	0	0	0	2	0	0	0
Processing	72	32	28	24	28	18	10	31	20	9	19	5
Machinery	42	10	10	10	18	35	26	22	16	9	20	3
Skill and dexterity	110	100	100	90	90	80	70	65	60	55	55	25
Accuracy	45	70	60	60	70	25	20	30	25	25	20	5
Mental effort	67	57	51	47	45	44	42	35	33	28	27	23
Education	85	70	60	60	60	50	50	30	40	30	30	20
Experience	120	120	120	105	105	60	45	23	15	8	8	3
Working conditions:												
Hazards	13	24	26	17	15	30	23	34	22	22	11	15
Surroundings	20	30	30	30	10	30	30	30	30	30	20	30
Expense	0	3	2	3	2	2	0	3	2	3	2	3
Physical effort	39	37	42	39	26	34	34	27	30	53	25	33
Fatigue	31	32	33	31	20	29	28	24	25	34	20	25
Total points	662	611	580	529	492	469	416	386	337	315	264	197

* *Code:*

1. Roller, 40-in. blooming mill
2. Ironworker A
3. Blacksmith A
4. Pipe fitter A
5. Roll turner A
6. Charging-machine operator
7. Dinkey engineer (steam)
8. Flying shearman—3 line
9. Salt annealer
10. Chipper A
11. Billet pusher
12. Shakerman

using job factors compare the jobs being evaluated with each other on each factor separately. The distinguishing feature about the Benge method is not the factor-comparison aspect but the fact that it does not evaluate jobs in points but in dollars.

According to Benge[3] the procedure is as follows:

> To compare jobs, especially where the duties are entirely unlike, it is necessary to consider factors common to all jobs. In the Factor Comparison Method these are:
>
> Mental Requirements
> Skill Requirements
> Physical Requirements
> Responsibility
> Working Conditions
>
> Select about 15 or 20 "key jobs" which are jobs clearly defined as to

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[3] *Ibid.*, pp. 41*ff*.

> duties, whose rates are not subject to controversy, which are not admittedly or comparatively underpaid or overpaid, and which vary in salary from the lowest to nearly the highest.
>
> From the descriptions of jobs based on information from employees and supervisors and checked by interviewers, rank the key jobs from lowest to highest in order of the importance of the first factor, Mental Requirements.
>
> Perform the same ranking operation of the key jobs for Skill. Do it also for Physical Requirements; again for Responsibility; and again for Working Conditions.
>
> Starting with the present typical or average salary for each of the key jobs, divide that salary into five parts, assigning one part to each of the five factors in accordance with its estimated importance.
>
> Now the committee of high-ranking operating officials and the job analysts compare all other jobs in the company with the key jobs. They place the new jobs in correct order of rank for each of the five factors, one at a time, by comparing them with the key jobs on the rating scales for each factor.

In other words, key jobs are scaled on each of five job factors in terms of dollars (or cents per hour), and other jobs are then evaluated in comparison. The dollar values for typical key jobs on each of the five job factors are given in Table 7–7. A job being evaluated that required about the same mental effort as a remittance clerk should pay $40 per month for this factor. Suppose the same job requires about

TABLE 7–7. RANK AND DOLLAR VALUES ON FIVE FACTORS FOR 10 KEY JOBS

Job	Mental		Skill		Physical		Responsibility		Working conditions		Total	
	Rank	$	Rank	$	Rank	$	Rank	$	Rank	$	Rank	$
Messenger	1	9	1	9	9	25	1	10	1	7	1	60
File clerk	3	16	2	19	3	16	2	21	1	7	2	79
Punch-card operator	2	14	4	27	3	16	4	22	7	10	3	89
Machine bookkeeper	4	17	4	27	7	17	5	25	8	11	4	97
Ediphone operator	6	25	6	32	3	16	2	21	1	7	5	101
Outside collector	5	20	3	20	9	25	6	31	10	18	6	114
Remittance clerk	8	40	7	36	1	13	7	60	1	7	7	156
Teller	7	30	8	38	8	18	7	60	8	11	8	157
Court accountant	9	42	9	40	1	13	9	55	1	7	8	157
Head bookkeeper	10	70	10	70	3	16	10	133	6	9	10	298

the same skill as a machine bookkeeper ($27), the same physical effort as a punch-card operator ($16), the same responsibilities as a court accountant ($55), and the same working conditions as an outside collector ($18). The job then should pay $156 per month.

The great advantage of this system is that a new set of key jobs, and consequently a new table of values, is developed for each evaluation situation. The jobs in two departments within the same plant may be evaluated on the basis of two tables of values, each derived from its own key jobs. All jobs are geared to those key jobs which are chosen by virtue of the fact that they carry wage rates that are satisfactory to both employees and management. Of course, this individualistic basis of evaluation may be a disadvantage if it is desired to standardize wages and make them uniform throughout a plant or for a region. It could happen that the key jobs are those performed by workmen who do not generally "squawk" for more money. The wage structure for an entire plant would be too low for this reason. However, with a job-evaluation committee composed of both workmen and management, this situation is not likely to arise.

There are two basic disadvantages to this method. First, the factors are ready-made and may not fit all jobs. For example, versatility may be an important factor in some jobs, keen auditory discrimination in others, and social gracefulness in others. If such jobs are judged only on the five factors mentioned above they may be evaluated lower than the whole picture would justify. Second, the value of the dollar is unstable while the relative value of jobs within the same plant, in fact throughout the country, is comparatively stable. Job evaluation should not be affected by the economic stability or instability of the country. Furthermore, it is easier for a job evaluator to be fair and unprejudiced in his work if he uses points instead of dollars. Of course points are eventually translated into dollars, but the job evaluator seldom knows the dollar value of his points and is more likely to be objective in his evaluations if he does not.

THE CUSTOM-MADE POINT SYSTEM

From the review of the four job evaluations just given it would seem that certain implications are justifiable.

1. Jobs should be evaluated on the basis of those factors which are significant in the jobs themselves, rather than on the basis of factors which are significant in other jobs in other situations.

2. Jobs should be evaluated in terms of points which can later be translated into dollar values, rather than in terms of dollar values directly.
3. In spite of certain disadvantages, it would seem that the most satisfactory basis for a job evaluation system is a careful analysis of those jobs (referred to above as key jobs) which are typical of those to be evaluated.
4. Factor and degree weights should be adjusted to fit the present wage rates of the key jobs.

If these implications are followed as guiding principles, a procedure or pattern of job evaluation is suggested which retains the values and avoids the limitations of the job evaluation systems described above. (Such a procedure has been applied successfully in both business and industrial situations with both salary and hourly paid employees.) All the following steps are not always followed literally in developing a new job evaluation system, but they are discarded or abridged only after careful consideration.[4]

Start with a Job Evaluation Committee. The determination of job values, like the determination of all other values, can be done only by human judgment. There is no purely objective way of measuring the worth of a job. The amount of certain factors can be measured (such as the pounds of material handled per hour, or the average time required for learning a job), but the weight of those factors must be determined by the judgment of someone. While there is but little value in mass judgment if it is naïve, two expert opinions are better than one. Job evaluation should be performed by a committee of experts, one of whom is familiar with the technique of job evaluation and the others familiar with the jobs being evaluated. Both management and labor should be represented—and by the best men available. The committee will thus be composed of highly paid men functioning on company time. This makes job evaluation a costly proposition. However, it must be remembered that the end result is a more equitable distribution of the payroll and is well worth the initial cost of installation.

There is always difficulty in getting a committee of busy officials to meet for any length of time without disrupting interruptions. The author has held meetings at night and even on Sundays to get a job evaluation program under way. The opinion of a committeeman is of little worth if he is half attending to something else. Sometimes individuals of lower official status and less responsibility are more useful on a job evaluation committee than vice-presidents.

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[4] See Gray, J. S. Custom-made systems of Job Evaluation, *J. Appl. Psychol.*, 1950, 34, 378–380.

The function of a job evaluation committee is largely that of review and consultation. The labor members of the committee carry information about what is going on back to their associates, and a large part of the educative process is thus taken care of. The whole process is easier with the assistance of a good committee.

Analyze All Jobs. First, analyze all jobs to be evaluated carefully and in as much detail as described in Chap. 2 of this book. Abbreviations of this analysis may be used on the job evaluation blank, but in the files of the company there should be a complete description of every job. Recently the dean of an engineering school explained to the author that his wide experience enabled him to evaluate jobs accurately (sic) without any formal analysis at all. This may be true in certain types of job evaluation but it would not be advisable with a job evaluation method as suggested below. A job analysis and description is necessary to be sure that all members of the committee are evaluating the same jobs. In job evaluation it is important to consider job content and not merely job titles.

Select Key Jobs. Key or bench-mark jobs are those that apparently are already properly evaluated. These should be selected by committee action. The over-all payroll must not be considered. Perhaps all jobs are underpaid. Key jobs are those that now carry their proper per cent of the payroll whether it is high or low. They should be at all wage levels and from all types of work. They should be representative samples of the jobs to be evaluated. Usually 15 or 20 are as many as needed. Of course, the list will be changed as the jobs are more carefully considered. Some will be dropped and others will be added.

Discover Job Factors. When the jobs are all analyzed and the key jobs selected, it is then necessary to study the analyses carefully to discover factors which distinguish jobs from each other. It must be remembered that job evaluation is a *comparative* study of jobs, a weighting of jobs in relation to each other, rather than a determination of the absolute value of jobs. With a payroll of a given amount, large or small, what is the most fair and just distribution? Factors which determine the relative weight of a group of clerical jobs may not determine the relative weight of a group of machine-operating jobs at all. For example, accuracy may be significant in one group of jobs and entirely unimportant in another. *Appropriate factors are those which exist in varied amounts in the jobs being evaluated.* If all jobs being evaluated are located underground, for example, this is not a factor in their evaluation.

The wide variety of factors which have been used in evaluating jobs is illustrated in Table 7–8.[5] Of course the mere title of a factor is not very meaningful. A factor as defined in one job evaluation manual may be identical with that defined in another manual but listed under a different title. The definition of a factor is, of course, more important than its title. Each factor should be very carefully defined.

TABLE 7–8. FACTORS SOMETIMES USED IN POINT SYSTEM OF JOB EVALUATION FOR HOURLY PAID EMPLOYEES

Education
Trade knowledge
Schooling
Experience
Training
Training time
Job knowledge
Dexterity
Accuracy
Mentality
Ingenuity
Initiative
Judgment
Intelligence
Resourcefulness
Versatility
Job skill
Attention to detail
Social skill
Quickness
Difficulty of operation
Precision
Foresight
Adaptability

Mental effort
Concentration
Visual Application
Physical effort
Mental fatigue
Physical fatigue
Monotony of work
Pace

Health hazards
Accident hazards
Lifting hazards
Exposure to dust
Exposure to dirt
Exposure to fumes
Exposure to weather
Exposure to noise
Exposure to vibration
Exposure to heat
Job security
Character of supervision
Hours of work

Responsibilities

Safety of others
Materials
Equipment
Process
Work of others
Supervision of others
Secrecy
Remembering
Cooperation
Quality of work
Following directions
Accuracy for
  Calculations
  Measurement
  Selection
  Recording
  Reading

Weight Job Factors in Per Cent of Total Wage. That is, decide what per cent of the total wage should pay for each factor selected. It is seldom wise to weight all job factors equally, as is done in Table 7–4. It is better that some factors outweigh others, as shown in Table 7–5. Most authorities believe that the skill factors (education, experience, training time, ingenuity) are as important as all other factors combined. This conclusion is substantiated by Lawshe and his associates in their factor-analysis studies of job evaluation.[6] In fact, they found that in one plant only two factors—skill demands and job characteristics—accounted for most of the differences between jobs even though the NEMA system with 11 factors (see Table 7–3) was used in the evaluation. In another plant, four factors—skill demands, nonhazardous job characteristics, hazardous job characteristics, and attention demands—accounted for most of the job differences. On the basis of these studies, Lawshe advocates the use of only three factors in job evaluation. However, according to his own data, 37.2 per cent of the jobs in one plant would have been displaced one labor grade and 0.8 per cent would have been displaced two labor grades. The need in job evaluation is not for fewer factors but for more accurate weighting of the factors regardless of their number.

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[5] Other lists are given by Otis, J. L., and Leukart, R. H., in *Job Evaluation,* p. 90, Prentice-Hall, Inc., New York, 1948.

The determination of what per cent of the total wage shall pay for each of the job factors selected will require long and earnest deliberation of the job evaluation committee. The weights given by other systems and the findings of studies such as Lawshe's should be carefully considered. However, the final decision will have to be made by the committee. Of course, any decision at this stage should be tentative and subject to later change. Nevertheless, it is important for this problem to be carefully thought through before going to the next step.

Construct a Table of Factor Levels, or Degrees, and Their Weights. Using the weights given to each factor as the value of the first degree, double this for the second degree, triple for the third degree, etc., for each factor. Five degrees may be used in the preliminary table with each degree value a multiple of the first factor value, as determined in the preceding step. (Such a table of factor degrees and weights is illustrated in Table 7–3.) Each degree should then be defined in terms of the amount of the factor represented. Suppose that the factor is "education." The first degree may be defined as "ability to read and write, make simple arithmetical computations, and understand simple oral directions; school-grade range equivalent, two to six." The second degree may be defined as "ability to add and subtract decimals and fractions, read simple drawings, and use simple calibration instruments; school-grade equivalent, seven to ten." Each degree for each factor should be thus defined.

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[6] Lawshe, C. H., *et al.*, Studies in Job Evaluation, *J. Appl. Psychol.*, I, 1944, 28, 189–198; II, 1945, 29, 177–184; III, 1946, 30, 117–128; IV, 1946, 30, 310–319; V, 1946, 30, 426–434; VI, 1947, 31, 355–365; VII, 1948, 32, 118–129.

When the tentative table of degree values is constructed and each degree defined, the key jobs should be evaluated. The points for each job should be totaled, the points for all together should be totaled, and the per cent of points for each job computed. This is illustrated in Tables 7–10 and 7–11. The same procedure should be followed for wages. (Of course, the wage rates for all jobs should be for the same duration, *i.e.,* for an hour, a day, or a month.) They should be totaled for all key jobs and the per cent of the total calculated for each. Now, the appropriateness of the table of values can be determined. If the percentage of total points for a job is approximately the same as the percentage of total wages, the job has been accurately evaluated and the weight table for the degrees involved is appropriate. If the percentage of total points differs from the percentage of total wages for a key job, the weight table for the degrees involved is probably not appropriate. It is then necessary to adjust degree values, and even basic factor values, until the key jobs are evaluated in accordance with the wages now paid.[7]

If some of the key jobs are at the higher wage levels, especially at the supervisory levels, it may be necessary to increase the weight of the higher degrees beyond that of arithmetical progression, as suggested above. For example, it may be necessary to make the fifth degree 5.5 times that of the first degree instead of only 5 times; the sixth degree may be 7 times the base value instead of only 6 times, etc. Wages at the higher levels can seldom be justified by straight-line arithmetical progression in a table of degree values.[8]

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[7] The procedure for determining whether the difference between the percentage of total points and the percentage of total wages for a given key job is great enough to justify correction of the evaluation system, is to calculate the statistical significance of that difference. This is sometimes called the "critical ratio" and indicates the extent to which the difference is due to chance. If the critical ratio is small it means that the difference is not significant. If it is large, say 2.5 or higher, it means that the difference is a true one and would probably not be reversed by further investigation. The formula for this calculation is given later on in this chapter.

[8] It may be argued that a job-evaluation system should attempt to evaluate all

Evaluate All Jobs That Have Been Analyzed. When factor and degree values have been so arranged that key jobs are evaluated in accordance with the wage rates they now carry, it is time to evaluate all other jobs in the company. This should be done by each member of the committee separately. It takes time, but several expert judgments are better than one. If the committee has functioned in every stage of the construction of the system, as suggested in the preceding six steps, they are all sufficiently familiar with it to use it expertly in actual evaluation. Their several evaluations should then be summarized and disagreements discussed and resolved in committee meetings.

The "horizontal" method of evaluating jobs has been found to be superior to the "vertical" method. That is, all jobs should be evaluated on the first factor before any jobs are evaluated on the second factor. (The more usual "vertical" procedure is to evaluate each job separately on all factors.) There are a number of advantages of the horizontal over the vertical method. First, jobs are constantly being compared with each other. They are not evaluated independently but in relationship to each other. Second, the "halo" effect is reduced. That is, a job that is properly rated high on one factor is not so likely to be overrated on other factors. Third, the reliability of the horizontal method is higher than that of the vertical method. Correlations between committee members evaluating jobs horizontally are consistently higher than when the jobs are evaluated vertically. Of course, when all disagreements between differences in ratings are ironed out in committee meetings, the superiority of one method of original rating over another is diminished.

It is sometimes advisable to have jobs in certain departments evaluated by supervisors and others in addition to the evaluations of committee members. Disagreements within the committee can often be resolved in this way. Sometimes, in spite of careful job analysis and description, committee members are not adequately acquainted with highly specialized jobs to evaluate them fairly. Such jobs can be more accurately evaluated by immediate supervisors than by the evaluation committee. For such occasions it is well to list the jobs to be evaluated and provide

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jobs on the same basis, and if higher level jobs do not justify their rates they should be lowered. This is an ethical problem and need not concern the procedure of job evaluation. If a committee agrees that certain higher job levels are key jobs, the job evaluator should use them as such and adjust his table of degree values to fit them. Key jobs are guide posts and must be used as such regardless of ethical considerations.

the supervisors with careful verbal and written instructions in the procedure of job evaluation. They should be given a form for the first job factor and asked to write the names of the listed jobs under the appropriate degree (see Table 7–9). At a later date, they can be given another form for the second factor, and so on until all jobs have been classified under all factors. These supervisors should meet with the committee when the evaluations of these jobs are reviewed.

The superiority of a custom-made system of job evaluation over a ready-made system was demonstrated in one situation by Gray and

TABLE 7–9. BLANK FOR USE IN HORIZONTAL JOB EVALUATION

Supervisor______________________ Department______________________

You are asked to classify the jobs in your department, listed on the enclosed sheet, according to the *education* or *schooling* required for their performance. Study this blank carefully and write the name of each job in the space provided under the appropriate degree. Certain "key" jobs are already listed under each degree to guide you in classifying the jobs under your supervision. Be sure that you consider only this single factor—education—in your classification. At a later date you will be asked to classify your jobs on the basis of other factors.

I. Education

This refers to the basic knowledge or "scholastic content" essential as background to learning a job. It may be acquired by formal education, by outside study, or by experience on related work. How much education is necessary for learning the job without being handicapped?

First degree: The ability to read and write, add and subtract whole numbers, and understand simple oral and written directions. Equivalent to training in lower school grades.

Key jobs—laborer, punch-press operator

Second degree: The ability to add and subtract decimals and fractions, read simple drawings, and use simple calibration instruments. Equivalent to training in upper grades and first 2 years high school.

Key jobs—polisher and buffer, upsetter operator

Third degree: The ability to use advanced shop mathematics, interpret handbook formulas, and use a variety of precision instruments. Equivalent to training of high-school graduates.

Key jobs—carpenter, turret lathe operator

Fourth degree: The knowledge of a specialized field (such as, accounting, drafting, statistics, motion analysis) such as acquired in about 2 years of specialized post-high-school training.

Key jobs--electrician, detailer—design

Fifth degree: The knowledge of a technical field, such as mechanical engineering, which is normally acquired in 4 years of college training.

Key jobs—engineers, chemists, technical salesmen

Sixth degree: Specialized knowledge and training acquired in 2 or 3 years of graduate study.

Key jobs—plant physician, director of research

Jones.[9] They evaluated 50 jobs in a textile mill by the Smyth-Murphy system of job evaluation and also by a custom-made system developed from an analysis of key jobs in the mill being studied. The superiority of the latter system over the former is illustrated in Tables 7–10 and 7–11. Note that the critical ratios in Column 7 of Table 7–10 are much greater than those in Column 7 of Table 7–11, indicating that the custom-made system evaluated the key jobs more in accordance with their actual pay than did the other system.

The coefficient of correlation between the two systems of .90 ± .018 seems high until it is realized that the ready-made system misevaluated 19 jobs, as much or more than ½ sigma. This is shown in Table 7–12. The authors comment thus: "When these errors are translated into wage values at textile mill levels, they are more significant to the workmen concerned than any statistical treatment would indicate. The living standards of whole families are affected by pay differences indicated by a half-sigma difference."

VALIDITY OF JOB EVALUATION

A system of job evaluation can be validated by calculating the accuracy with which it evaluates key jobs (those assumed to carry proper

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[9] Gray, J. S., and Jones, M. C., Ready Made versus Custom Made Systems of Job Evaluation, *J. Appl. Psychol.*, 1951, 35, 11–14.

TABLE 7–10. CRITICAL RATIOS OF DIFFERENCES IN PERCENTAGES OF WAGES AND POINTS FOR KEY JOBS
(Smyth and Murphy system)

DOT code number	Job	(1) Hourly wage, cents	(2) Per cent of total wage	(3) Points	(4) Per cent of total points	(5) Diff. in per cents	(6) S.D. of points	(7) Diff. S.D. points
6–19.166	Doffer (spinning room)	0.85	5.6	160	5.1	.5	.40	1.25
6–19.117	Manual winder hand	0.87	5.7	170	5.4	.3	.41	.73
6–19.113	Auto quiller hand	0.88	5.8	151	4.8	1.0	.41	2.43
6–19.022	Frame operator (super draft)	0.91	6.0	168	5.3	.7	.42	1.67
6–19.533	Cloth inspector	0.92	6.0	188	6.0	0		
8–19.01	Blending machine operator	0.92	6.0	212	6.7	.7	.42	1.67
6–19.031	Card hand	0.94	6.2	182	5.8	.4	.43	.93
4–15.020	Weaver	0.96	6.3	205	6.5	.2	.43	.47
6–19.041	Spinner	0.98	6.4	181	5.7	.7	.44	1.59
6–19.226	Slasher hand	1.06	6.9	237	7.5	.6	.45	1.33
6–19.827	Tying-in machine operator	1.10	7.2	220	7.0	.2	.46	.43
5–83.641	Winder room section hand	1.21	7.9	286	9.1	1.2	.48	2.50
5–83.324	Spinning room section hand	1.21	7.9	271	8.6	.7	.48	1.46
6–18.220	Card grinder	1.21	7.9	265	8.4	.5	.48	1.04
4–16.010	Loom fixer	1.25	8.2	260	8.2	0		
	Total	15.27	100.00	3156	100.0			

TABLE 7-11. CRITICAL RATIOS OF DIFFERENCES IN PERCENTAGES OF WAGES AND POINTS FOR KEY JOBS
(Custom-made system)

DOT code number	Job	(1) Hourly wage	(2) Per cent of total wage	(3) Points	(4) Per cent of total points	(5) Diff. in per cents	(6) S.D. of points	(7) Diff. S.D. points
6–19.166	Doffer (spinning room)	0.85	5.6	125	5.6	0		
6–19.177	Manual winder hand	0.87	5.7	123	5.5	.2	.49	.41
6–19.113	Auto quiller hand	0.88	5.8	134	6.0	.2	.49	.41
6–19.022	Frame operator (super draft)	0.91	6.0	136	6.1	.1	.50	.20
6–19.533	Cloth inspector	0.92	6.0	136	6.1	.1	.50	.20
8–19.01	Blanding machine operator	0.92	6.0	132	5.9	.1	.50	.20
6–19.031	Card hand	0.94	6.2	138	6.1	.1	.51	.20
4–15.020	Weaver	0.96	6.3	148	6.6	.3	.51	.59
6–19.041	Spinner	0.98	6.4	142	6.3	.1	.52	.19
6–19.226	Slasher hand	1.06	6.9	151	6.7	.2	.54	.37
6–19.827	Tying-in machine operator	1.10	7.2	166	7.4	.2	.55	.36
5–83.641	Winder room section hand	1.21	7.9	172	7.7	.2	.57	.35
5–83.324	Spinning room section hand	1.21	7.9	178	7.9	0		
6–18.220	Card grinder	1.21	7.9	177	7.9	0		
4–16.010	Loom fixer	1.25	8.2	186	8.3	.1	.58	.17
	Total	15.27	100.0	2244	100.0			

TABLE 7–12. FREQUENCY WITH WHICH 50 JOBS WERE EVALUATED DIFFERENTLY BY THE TWO SYSTEMS OF JOB EVALUATION IN UNITS OF ONE-TENTH SIGMA

Sigma Value Differences	No. of Jobs	Sigma Value Differences	No. of Jobs
0.0	3	.6	3
.1	4	.7	2
.2	12	.8	3
.3	6	.9	0
.4	6	1.0	2
.5	9	Total......	50

pay rates already). If a key job carries 10 per cent of the total pay for a group of jobs, and if it is evaluated at 10 per cent of the total evaluation points for those same jobs, the system of evaluation is then valid. Of course, it is difficult to get a system of job evaluation that will evaluate all key jobs exactly as they are paid. When there is a difference between the evaluation and the pay of the key jobs, it is then necessary to calculate the statistical significance of that difference. If this is significant, the evaluation system must be changed until all differences between the evaluation of key jobs and their pay rates are statistically insignificant. Tables 7–10 and 7–11 illustrate a valid and a less valid system of job evaluation. The critical ratios in Column 7 indicate the degree of validity when the pay of key jobs is taken as the criterion.[10] Of course this calculation of validity depends on the accuracy of the present pay of the key jobs. If these do not carry the proper wage rates in relation to the size of the total payroll, they are not then proper criteria for judging the worth of an evaluation system.

It sometimes happens that apparently invalid systems of job evaluation are not inherently invalid. Often a common base value can be added to the evaluation points of each job and the validity of a system raised thereby. For example, key-job A may carry a wage of $60 per week, and key job B, $102 per week. This is a ratio of 1 to 1.7. A system of job evaluation may give job A 210 points and job B 475 points. This is a ratio of 1 to 2.26. It is obvious without further calculation that the evaluation system is not valid. The ratio of the evaluation points of one key job to those of other key jobs must be approximately the same as the ratio of the wages of that key job to the wages of other key jobs.

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[10] The critical ratio of differences in percentage is calculated by dividing the difference by the standard error of the difference. The formula for the S.E. difference is $\sqrt{P_1Q_1/N_1 + P_2Q_2/N_2}$.

Now, what base value can be added to the evaluation points of all jobs to correct discrepant ratios? This can be determined by using a simple proportion equation—wage A is to wage B as points for A plus x is to points for B plus x. Using the data given above for jobs A and B, the equation is $\$60:\$102::210 + x:475 + x$. The solution of this equation gives X a value of 168.6 or 169. When this value is added to the original evaluation points of each job, job A has a value of 379 points and job B, 644. The ratio of the two jobs in points is now 1 to 1.7, or the same as the ratio of wages.[11]

RELIABILITY OF JOB EVALUATION

Any procedure which affects the income of men should be as accurate as possible. What is the percentage of error of job evaluation? What is the correlation between the rating of two job evaluators? This problem has not been studied to the same extent as has the reliability of various employment tests. Otis and Leukart[12] report a correlation of .984 between a set of "original job ratings" and the "revised ratings." This is well above the minimum of .80 usually advocated for psychological test reliability. However, it is higher than this author has found between the original ratings of members of job evaluation committees. These are usually in the middle eighties. In fact, the correlation between two trained evaluators using the NMT point system for 40 jobs in a steel fabricating plant was only .87. A reliability correlation of .984 is more in line with that between committee members *after* revision following meetings on evaluation disagreements.

If a custom-made point system (similar to that suggested above) is used and conferences are held on disagreements, the correlations between final evaluations of committee members are invariably in the high nineties. In fact, when a committee is in disagreement on the evaluation of a job after a conference, it is evidence that someone is unacquainted with the job in question or with the meaning of the evaluation factors and their degrees. Further meetings should be held until significant disagreements are resolved. Thus, a high reliability of job evaluation is forced by the nature of the procedure.

JOB EVALUATION AND WAGE RATES

When jobs are evaluated, they are often classified into "labor grades" which carry specific wage limits. For example, all jobs which are evaluated in point values between 250 and 271 may be in labor grade 6. This grade may pay between \$1.07 per hour and \$1.18 per hour. Exactly what a workman will get within this range is best determined by that procedure known as "merit rating," discussed in the preceding chapter.

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[11] See, Gray, J. S., Adjusting Base Weights in Job Evaluation, *J. Appl. Psychol.*, 1951, 35, 8–10.

[12] *Op. cit.*, p. 297.

Point values are sometimes translated into wage rates directly by dividing the total wages of the key jobs by the total point values of the key jobs. This gives the money value of each point. The point values of other jobs can then be multiplied by this money value to obtain the proper wage rates. In Table 7–11, the hourly wage value of each point is .0068. One of the other jobs evaluated had a point value of 206 points. This justified a wage of \$1.40 per hour. (The actual rate of pay was only \$1.25 per hour and was adjusted to conform to the point evaluation.) If a wage range is desired for this sort of point-value translation, a plus or minus percentage can be arbitrarily chosen. In the above illustration, the range was plus or minus 10 per cent. The job just mentioned carried a wage range of \$1.26 to \$1.54 per hour. As suggested above, the actual rate within the job range should be determined by merit rating.

SUMMARY

Jobs are evaluated by ranking in order of value; by classifying into grades or groups of graduated value; by assigning points for value in various job traits or factors assumed to be present in varied degree in all jobs; by assigning money for value in various job traits or factors in comparison with predetermined money worth of certain key jobs in each factor; and by assigning points for value in factors discovered to be present in key jobs. The last method, called the "custom-made" system, is constructed to fit the peculiar nature of each establishment. Its validity is determined by evaluating key jobs in accordance with the wage rates they now carry.

RECOMMENDED READINGS

Benge, E. J., Burk, S. L. H., and Hay, E. N.: *Job Evaluation*, Harper & Brothers. New York, 1941.

Ghiselli, E. E., and Brown, C. W.: *Personnel and Industrial Psychology*, Chap. 2, McGraw-Hill Book Company, Inc., New York, 1948.

Johnson, F. H., Boise, R. W., and Pratt, D.: *Job Evaluation*, John Wiley & Sons, Inc., New York, 1946.

Jones, P. W.: *Practical Job Evaluation*, John Wiley & Sons, Inc., New York, 1948.

National Industrial Conference Board: *Studies in Personnel Policy,* New York. No. 25, Job Evaluation; No. 33, Problems in Wage Adjustment; No. 62, Principles and Application of Job Evaluation.

OTIS, J. L., and LEUKART, R. H.: *Job Evaluation,* Prentice-Hall, Inc., New York, 1948.

SMYTH, R. C., and MURPHY, M. J.: *Job Evaluation and Employee Rating,* McGraw-Hill Book Company, Inc., New York, 1946.

STIGERS, M. F., and REED, E. G.: *Theory and Practice of Job Rating,* McGraw-Hill Book Company, Inc., New York, 1942.

TIFFIN, J.: *Industrial Psychology,* Chap. 11, Prentice-Hall, Inc., New York, 1947.

War Manpower Commission: *Industrial Job Evaluation Systems,* Government Printing Office, Washington, D.C., 1943.

Chapter 8

NUTRITION AND REST

Nutrition
  Evidence of Nutritional Deficiency
  Food Intake and Industrial Output
  Proper Diet
  Instituting Nutritional Programs
    Educating Workmen in Nutrition
    Educating Workers' Wives in Nutrition
Rest
  Rest during Work
  Rest between Workdays
  Rest between Weeks
  Yearly Rest Periods—Vacations
Summary

Health has always been recognized as a factor which affects the efficiency of any working force, but, unfortunately, too little has been done about it. Industries try to hire healthy workmen[1] and often give "sick leave with pay" but seldom investigate and attempt to correct the causes of poor health. Of course, many industries have "health-service programs" which provide for treating certain remediable physical defects, hospitalization for ill or injured employees, nursing services (often including home visitation), first-aid instruction, dental care, and recreational programs. Certain health hazards are controlled, often by legal specifications, and the importance of good health is usually emphasized through some sort of health-education program. Nevertheless, good health is more talked about and advocated than *caused* to exist. Those factors which produce good health have been promoted only in isolated industries.

While good health is dependent on a great many factors, two are of outstanding importance—nutrition and rest.

NUTRITION

As indicated in Chap. 1, food values in the body are expressed in terms of the heat units produced in the process of transforming food into energy. While the body is not a heat engine, heat is produced and indicates the amount of potential energy in food which may be released in body function. The unit of heat measurement is the large calorie, or the amount of heat necessary to raise 1 kg. of water 1°C. (This is approximately equivalent to the amount of heat required to raise the temperature of 2 qts. of water 1°F.)

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[1] A physical examination is usually a part of an employment program.

Foods consist of three basic compounds: carbohydrates, proteins, and fats. The body food value (after correction for loss in digestion) for each compound is as follows:

Carbohydrates	4 Cal. per g.
Proteins	4 Cal. per g.
Fats	9 Cal. per g.

When the composition of food is known, the Calorie values can be calculated. For example, milk is composed of 4.9 per cent carbohydrate, 3.5 per cent protein, and 3.9 per cent fat. Consequently, 100 g. of milk (about 3.5 oz.) contains 19.6 Cal. of carbohydrate food value (4.9 × 4), 14 Cal. of protein food value (3.5 × 4), and 35.1 Cal. of fat food value (3.9 × 9), or a total of 68.7 Cal. Values for other foods are shown in Table 1–1.

An adequate balanced diet requires that 10 to 15 per cent of the food intake consist of proteins, 60 to 75 per cent of carbohydrates, and 15 to 25 per cent of fats. These percentages vary somewhat with individuals (size, age, etc.), the nature of the work performed, and the season of the year. Also, certain vitamins are essential for health. Each vitamin has a specific value, and its deficiency soon has a noticeable effect on the body.

Vitamin A is called the "antibacteria" vitamin. It is found in cream, butter, fish liver oils, eggs, leafy vegetables, yellow corn, sweet potatoes, cantaloupe, peaches, tomatoes, etc. It is stored in the body and is destroyed by cooking. A deficiency of vitamin A increases the dangers of infections in the eyes, nose, sinuses, throat, lungs, and skin. Pneumonia and kidney diseases are more easily contracted. "Night blindness" is a symptom of such deficiency.

Vitamin B_1 is the "antineurotic" vitamin. It is found in dried brewer's yeast, cereal germ, whole-wheat meals, bran, milk, egg yolk, etc. It is not destroyed by ordinary cooking. It is not stored in the body, so food containing this vitamin must be eaten daily. A deficiency of vitamin B causes loss of appetite, poor digestion, constipation, loss of weight, nervous disorders, and reduced lactation in nursing mothers. Loss of appetite and nervousness are common symptoms.

Vitamin C is the "antiscurvy" vitamin. It is found in citrus fruits, fresh raw fruits, and raw green vegetables (especially tomatoes). It is destroyed by cooking. It is not stored in the body, so it must be supplied in the food daily. Its deficiency causes tooth decay, pyorrhea, gum bleeding and brittle bones. Common symptoms are bad teeth and mouth ulcers.

Vitamin D is called the "antirickets" vitamin. It is found in fish liver oil (especially halibut and codfish), egg yolk, and is formed by the body itself when tanned by sunlight (or any source of ultraviolet rays). Vitamin D is stored in the body and is not destroyed by cooking. It has been estimated that at least 80 per cent of our children are affected more or less by the lack of this vitamin. Such deficiency causes inferior bone development and "pot bellies." Bowed legs and crooked spines are common symptoms.

Vitamin E is the "antisterility" vitamin. It is found in egg yolk, leafy vegetables, grain germ, beans, nuts, milk, cottonseed oil, fruits, meat fats, etc. It is stored in the body and is not affected by cooking. Its deficiency causes sterility in males and miscarriages in females. However, it is present in such a great variety of foods that deficiency is rare.

Vitamin P-P is the "antipellagra" vitamin. It is found in dried yeast, liver, milk, lean meat, etc. It is not stored in the body and is not affected by cooking. Its deficiency reduces the resistance of the skin to irritations, infections, etc. Common symptoms are wrinkled and blotched skin.

In addition to vitamins, minerals are also important elements in human food. *Calcium* or lime is required for bone development. There are about 4 lb. in the average adult. Calcium is found in dairy products, nuts, oysters, celery, kale, etc. It is stored in the body, but a constant supply (½ g. daily) is necessary. It is not destroyed by cooking the foods in which it is found. Closely associated with calicum in the body is another important mineral, *phosphorus*. It is an essential element in every cell and in all chemical action within the body. It appears in dairy products, eggs, lean meats, vegetables, etc. It is not destroyed by cooking, but must be taken into the body daily.

There are other minerals which are also essential in body development, but only rarely are they found lacking. They are chlorine, cobalt, copper, iodine, iron, magnesium, manganese, potassium, sodium, sulphur, and zinc. There are also other vitamins which have been discovered, but they have not yet been studied carefully enough to be adequately described. These are B_3, B_4, B_6, B_{12}, K. Progress just now is very rapid in discovering new facts about foods and their function in the body.

Table 8–1 shows the important vitamins and minerals and the foods in which they are found most abundantly. It also shows the effects of a deficiency of these food elements in the body.

There are a great number of foolish ideas about food which have no scientific justification. The following statements of facts regarding foods are given to correct some of these foolish notions:

1. Nuts do not possess all the essential food elements.
2. Whole-wheat bread supplies more vitamins and minerals but less energy than white bread.
3. Raw vegetables should be taken in moderate quantity. Excessive amounts are injurious.
4. Salt improves food value as well as taste.
5. Acid (sour) fruits cause an alkaline reaction in the body.
6. It is not harmful to eat sea foods (especially fish and oysters) with dairy products. Fish and milk do mix.
7. Aluminum, iron, and tin cooking utensils do not cause food poisoning. Neither is canned food contaminated by being left in an opened can, if it is kept cool.

There are four ways of studying the food requirements of the body. They are as follows:

1. Checking the amount and kinds of food consumed (dietary studies).
2. Measuring the amount of oxygen consumed, or carbon dioxide produced, or both (respiration studies).
3. Measuring the amount of food intake and energy output (carbon and nitrogen balance studies).
4. Measuring the amount of heat given off by the body (calorimeter studies).

All four methods are strikingly consistent when used to measure the energy requirements of workmen at various types of work. Typical data from such studies are shown in Table 1–2.

Food is used in the body for two purposes—to build tissue and to enable tissue to function. The process of converting food into either body tissue or tissue energy is called *metabolism*. That metabolism necessary for the bare maintenance of life is called *basal metabolism*. From 1600 to 1800 Cal. per day, depending on the size and weight of the individual, are necessary for basal metabolism. The rate of metabolism beyond this

TABLE 8–1. VITAMINS AND MINERALS AND THEIR CHARACTERISTICS

Principal vitamins and minerals	Foods found in	Deficiency symptoms
A: Antibacteria Stored in body Destroyed by cooking	Milk fats, cream, butter Fish liver oils Egg yolk Raw green vegetables (kale, spinach) Carrots, tomatoes, cheese, liver	Infections of mucous membrane Sore eyes Sinus difficulties Kidney trouble Frequent colds Retarded growth Shortens life span Diarrhea
B (B_1) (thiamin): Antineurotic Must be eaten daily Not destroyed by cooking	Dried yeast Wheat germ Whole-grain foods Leafy vegetables Dried beans, peas Bran, spinach, egg yolk Whole milk, tomatoes Asparagus, liver	Poor appetite Poor digestion Constipation Nervousness Retarded growth
C (ascorbic acid): Antiscurvy Must be eaten daily Destroyed by cooking and drying	Citrus fruits (grapefruit, oranges, lemons) Raw green vegetables Fresh raw fruits (strawberries, pineapple) Tomatoes	Sore mouth Sore joints Retarded growth Bad teeth Anemia
D: Antirickets Stored in body Not destroyed by cooking	Fish liver oils Egg yolk Sunshine Viosterol Liver	Bowlegs Knock-knees Poor teeth
E: Antisterility Stored in body Not destroyed by cooking	Most foods—especially in whole grains Leafy vegetables Fresh meats	Deficiency seldom occurs
G (B_2) (riboflavin): Essential for tissue respiration Not destroyed by cooking	Green vegetables Sea food Dairy products Liver	Loss of hair Loss of weight Bodily weakness

TABLE 8–1. (*Continued.*)

Principal vitamins and minerals	Foods found in	Deficiency symptoms
P-P (nicotinic acid): Antipellagra Must be eaten daily Not destroyed by cooking	Dried yeast Liver Lean meat Wheat germ	Skin irritations and infections Poor appetite Red tongue Diarrhea Vomiting
Calcium: Required for bone development Not destroyed by cooking	Beans, oysters Cheese, cream, egg yolk Turnip tops, nuts Cauliflower, celery Kale	Poor development of bones Bad teeth Nose bleeding
Phosphorus: Essential elements in all cells and in all body chemistry Not destroyed by cooking	Cheese, egg yolk Whole-grain meals Milk, lean meats Nuts, fish, carrots Spinach, tomatoes Cabbage	Retarded growth Poor appetite Loss of weight
Iron: Essential for tissue respiration and formation of hemoglobin	Egg yolk, heart Oatmeal, kidney Whole wheat Dried beans	Low vitality Retarded growth Anemia
Iodine: Necessary for normal function of thyroid gland	Cod liver oil Sea food Broccoli Iodized salt	Susceptible to infections Cretinism Myxedema

Other vitamins and minerals

Vitamin B_6—Found in seed oils, lard, egg yolk, etc., essential to skin health

Vitamin K—Found in leafy vegetables, egg yolk, liver, etc., important for blood coagulation

Chlorine—Found in bread, cheese, oysters, etc., essential for digestion and tissue retention of water

Magnesium—Found in beans, raisins, whole grains, etc., important for muscle action, bowel movement, etc.

Potassium—Found in dairy products, sea food, liver, etc., important in growth, digestion, and heart action

Copper—Found in bran, cocoa, nuts, sea food, etc., important in growth of red blood cells and utilization of iron base level is determined by the activity of the body. The Calories necessary for any activity beyond the basal level are called "work calories." A great amount of activity requires an additional amount (and kind) of food to supply the additional Calories. In other words, heavy manual labor involves more metabolism and necessitates more food than does work of a sedentary nature. (The Calories necessary for various kinds of activity are shown in Table 8–2.) It is estimated that a shoemaker can get along on 700 to 900 work calories per day, while a carpenter requires from 1200 to 1400. The relation of Calorie intake to energy output has been the subject of some interesting studies.

TABLE 8–2. CALORIES PER HOUR PER POUND NECESSARY FOR VARIOUS TYPES OF ACTIVITY

Activity	Calories	Activity	Calories
Sleeping	0.43	Walking—2.6 miles per hour	1.56
Awake, lying still	0.50	Walking—3.75 miles per hour	1.95
Sitting at rest	0.65	Walking downstairs	2.36
Reading aloud	0.69	Sawing wood	3.12
Standing at attention	0.74	Swimming	3.25
Dressing and undressing	0.77	Running—5.3 miles per hour	3.70
Typewriting rapidly	0.91	Walking—5.3 miles per hour	4.22
Sweeping (38 strokes per minute)	1.09	Walking upstairs	7.18
Shoemaking	1.17		

EVIDENCE OF NUTRITIONAL DEFICIENCY

The fact that workmen do not eat enough of the proper kinds of food is evidenced from almost any study of diet adequacy. Table 8–3

TABLE 8–3. TEN TYPICAL STUDIES SHOWING PERCENTAGE OF WORKMEN GETTING ADEQUATE, BORDERLINE, AND INADEQUATE FOOD CONTENT

Studies	Nature of food content		
	Adequate	Borderline	Inadequate
1	8	21	71
2	14	22	64
3	9	36	55
4	4	21	75
5	20	58	22
6	2	11	87
7	14	46	40
8	26	48	26
9	39	42	19
10	52	45	3

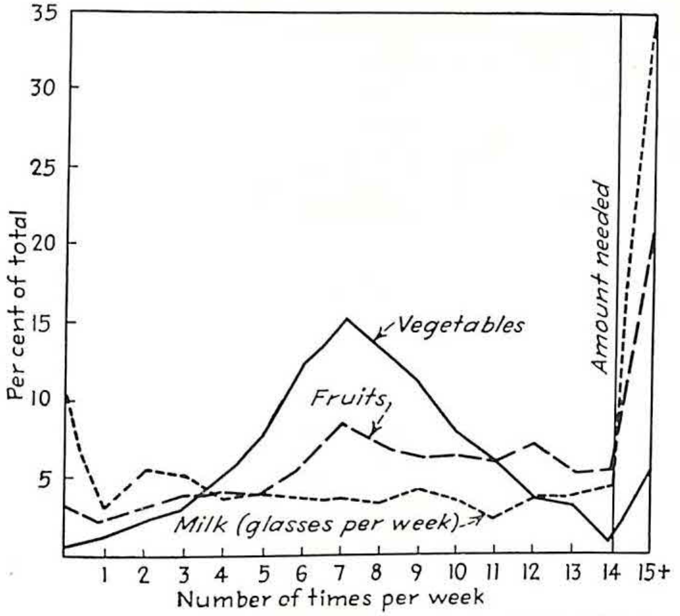

FIG. 8–1. Vegetable, fruit, and milk diets of employees (N 1,103) in an aircraft factory. (Weekly average for period November, 1941, to February, 1942.)

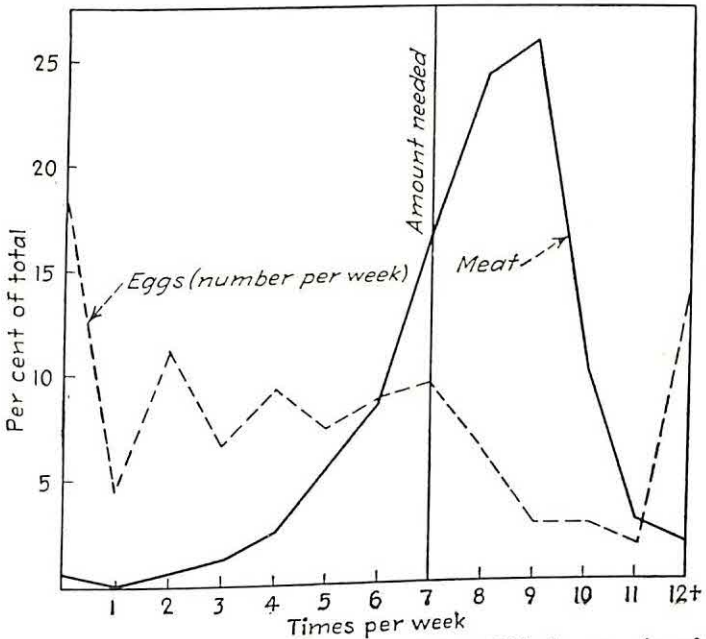

FIG. 8–2. Meat-and-eggs diets of employees (N 1,103) in an aircraft factory. (Weekly average for period November, 1941, to February, 1942.)

summarizes 10 such studies. Others are reviewed in various publications on nutrition.[2] Some workers do not get enough Calories, others do not get enough vitamins, and others do not get enough minerals. Weihl[3] studied the diets of aircraft workers during the first years of the Second World War and found that only a small percentage of them ate the proper foods to give them all food essentials. She found that 56 per cent ate too little green and yellow vegetables, 49 per cent ate too little citrus fruits and tomatoes, 33 per cent drank too little milk, 23 per cent ate too few eggs, but only 1 per cent ate too little lean meat. Other findings are shown in Figs. 8–1 and 8–2.

The National Research Council[4] has calculated, from data obtained from all over the world, the amount of body weight loss from various degrees of substandard food intake and the effects of these losses in body weight on mortality and work performance. These calculations are shown in Tables 8–4 and 8–5.

TABLE 8–4. ESTIMATED BODY WEIGHT LOSSES RESULTING FROM VARIOUS DEGREES OF SUBNORMAL CALORIE INTAKE *

Duration, months	Calorie intake reduction, per cent							
	10	20	30	40	50	60	70	80
3	5	7	9	12	15	20	25	30
6	7	11	15	19	25	30	35	40
12	8	13	18	25	30	35	40	
18	9	14	20	28	34	40		

* These effects will be exceeded if there is marked dysentery, and masked by excessive edema if diet is unusually deficient in proteins.

A clinical study of the nutritional status of aircraft workers[5] showed that "nearly every subject (N 1,172) showed evidence of vitamin A deficiency," 17 per cent showed evidence of thiamin (vitamin B_1) deficiency, 9 per cent showed evidence of riboflavin (vitamin G) defi-

[2] See *National Research Council Report*, Nos. 110, and 123, April, 1942, September, 1945.

[3] Weihl, Dorothy G., Diets of a Group of Aircraft Workers, *Milbank Memorial Fund Quart.*, 1942, 22, 329–366.

[4] *Calorie-consumption Levels and Their Relation to Health, Well-being, and Capacity for Work*, Memorandum on Questions Submitted by the Cabinet Committee on World Food Programs, Dec. 13, 1946.

[5] Borsook, H., Alpert, E., and Keighley, G. L., Nutritional Status of Aircraft Workers in Southern California, *Milbank Memorial Fund Quart.*, 1943, 21, 116–157.

TABLE 8-5. ESTIMATED EFFECTS OF VARIOUS LOSSES IN BODY WEIGHT DUE TO MALNUTRITION

Effect	Body weight loss, per cent of normal						
	5	10	15	20	30	40	50
Mortality rate	. . .	+10	+30	+100	+700	+3,000	Total
T.B. deaths	+5	+20	+40	+100	+200		
Starvation deaths	0	0	+.5	+ 5	+ 20	+ 50	+95
Physical work performance	−5	−20	−40	− 70	− 95	Nil	Nil
Clerical work performance		−10	−25	− 50	− 80	− 95	Nil

ciency, 32 per cent had subnormal plasma ascorbic-acid (vitamin C) concentration, and 40 per cent had gastrointestinal disturbances attributed to inadequate diet. As most of the group was under 30 years of age (73 per cent), the findings were considered especially significant.

Miss Weihl found in her study that even the Calorie intake of 40 per cent of the workers studied was insufficient for men engaged in work involving physical activity. A study of 93 male wage earners in Toronto, Canada,[6] showed that the average Calorie intake was 2540, whereas at least 3000 is considered necessary for a working man.

These data are typical of numerous studies of nutritional sufficiency. There is widespread malnutrition among American workmen, due not primarily to insufficient amounts of food (although this does exist), but to the improper selection of foods and improper processing. Later in this chapter the characteristics of proper diets will be discussed.

FOOD INTAKE AND INDUSTRIAL OUTPUT

One of the best studies of the relation of food intake to industrial output was made at the Kaiser-Wilhelm-Institut für Arbeitsphysiologie during the Second World War.[7] It is here quoted because it is so well-reported by the authors.

> In 1942, 20 workmen, fed entirely by their factory, were occupied in the erection of an embankment inside the works. Their task was composed of dumping debris out of railway cars and changing the rails to advance the points of dumping. A measure of the work done was given by the number of tons of debris dumped per hour and man. At the beginning the work-

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[6] Palterson, J., and McHenry, E. W., A Dietary Investigation in Toronto Families, *Can. Publ. Hlth. J.*, 1941, 32.

[7] Kraut, H. A., and Fuller, E. A., Calorie Intake and Industrial Output, *Science*, 1946, **104**, 495–497.

men did not receive the rations for heavy workers. They had, besides their calories for resting metabolism, 820 work calories per day and dumped 1.5 tons per hour. Our observations, results of which are given in Fig. 8–3, started after several months of work of this kind. Neither the workmen nor the personnel charged with the supervision and inspection of the workers were informed about our investigations. Three weeks later the workmen received the rations for heavy workers except when difficulties in transport made this impossible. This resulted in unequal nutrition. The output of the workmen changed parallel to these enforced variations in available work calories. After one year 2.2 tons per man and hour were dumped with an average of 1,300 work calories. The body weight of the workers increased about 4 kg. during that year, proving that the capacity for work, given in the rations for heavy work, was not fully utilized. Since the termination of the embankment was urgent, the workers were promised cigarettes for greater production. At first, 2.5 tons per hour was the minimum production for which this premium was awarded; after several weeks the premium was graduated, the maximum being given for 3 tons and later on even for 4 tons. This induced a considerable increase of output, 3 tons soon being attained by nearly every man; after the last increase of the premium limit the average output reached 3.4 tons. The premium system lasted for the last half year of the embankment construction, during which time the 20 workers lost, on the average, 3.5 kg. of weight.

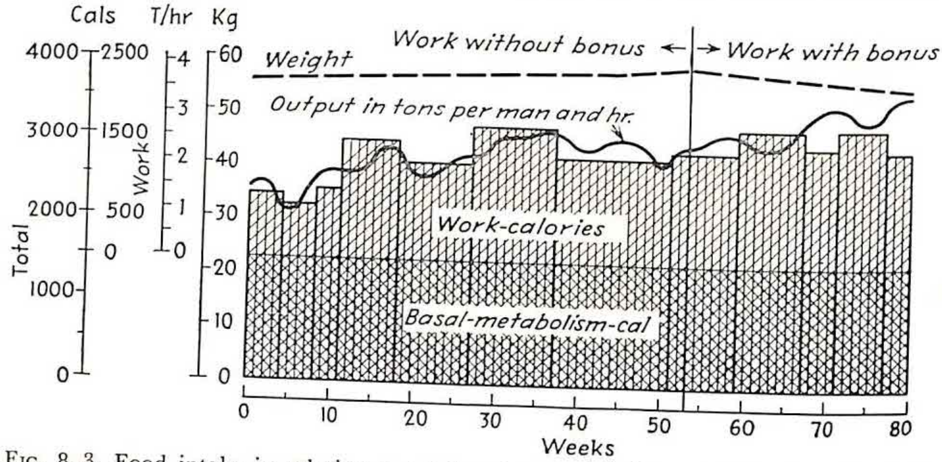

FIG. 8–3. Food intake in relation to work output and body weight in shoveling dirt.

The result of these observations is clear. In the time without premiums production varied directly with available calories, yet the actual production differed enough from the energy equivalent of the rations to allow an increase in body weight. With the awarding of cigarette premiums the proportionality between output and available calories was lost at once.

Output surpassed so much the range of calorie possibilities that the deficit had to be made up continuously from the very substance of the body.

A second investigation was undertaken in 1943 with a group of 31 miners. These miners were 20–30 years of age when they started working as miners, and at the time of the study they had just finished their training as "cutters." During the training period a total of 2,800 calories, allowing 1,200 work calories per day, was given, securing a daily output of 7.0 tons of coal per man. They used, therefore, 170 work calories per ton. At our suggestion these workers received 400 extra calories per day and thereby increased their daily output to 9.6 tons per man. Expending now 155 work calories per ton, they lost in six weeks, on the average, 1.2 kg. of body weight. The number of extra calories was then raised to 800. In consequence, the output increased a little (to 10 tons), and the body weight slowly returned to its original value. The actual requirement is, therefore, to be found between 155 and 200 calories per ton.

Further experiments were conducted in steelworks in 1944. On our advice 400 extra calories per day were given to the workers living in a camp. Workmen occupied on a steam hammer thereby increased their output 22 per cent, simultaneously increasing their body weight slightly. Sixteen other workers were occupied on a 1,500 ton press, already being used at its capacity; hence, the production of these workers could not increase, and in three months the body weight increased from 67 kg. to 72.5 kg. on the average.

The best example of the connection between nutrition and output is given by the coal production of the Ruhr district during the war. In Fig. 8–4 are plotted the calories of the rations during the war and the output of the workers in the pits of the Ruhr coal mines from September 1939 to September 1944. The total caloric consumption of the miners working in the pits before the war, depending on the job, varied from 3,600 to 4,800. In agreement with these figures the output of the first year of war was but little lower, the ration then being 4,200 calories. From 1,150 to 1,200 work calories were needed per ton of coal mined. These needs cover the whole number of miners employed underground and not merely cutters, as in our investigation of 1943. When in the course of the second year of war rations were cut somewhat, the output went down exactly as expected from the fall in available work calories. The first major cut in rations, which occurred in April, 1942, was not followed immediately by a decreased output, as shown in the two upper curves of Fig. 8–4. Instead, the workers, in trying to keep up production, contributed calories out of their body substance. The lower curve, which shows the calories available per ton of coal mined, fell rapidly from April 1942 down to 900 calories per ton. Very soon, however, the curve rose and by autumn of 1942 again exceeded 1,100 calories per ton. From the summer of 1943 to the end of the observations in the autumn of 1944 it was always between 1,150 and 1,200 calories, its original height. The production of a single plant did not always show the connection with the calorie supply because of the numerous troubles caused by war. However, our review of the whole production of the Ruhr district demonstrates quite clearly that the fall of coal output during the war was primarily due to the cuts in rations.

Exactly the same observations have been made after the war, during the resumption of work. Investigations of the calorie consumption of workers in bridge-building works in Dortmund in the autumn of 1945 demonstrated that the work done was in accordance with the rations provided. The allowances of 2,200 calories for men doing heavy work and 2,700 calories for those doing the heaviest work permitted about half the amount of peacetime work. Bad as this result is from the point of view of production it really touches the workman's health only slightly. With his rations and extras he first satisfies his resting metabolism and the needs of his leisure hours. He does as much work with the rest as is actually possible. The consumer of the basic rations of 1,500 calories, however, can barely keep up his resting metabolism. For his leisure and professional work he is bound to use his body substance or secure illegal food. These conditions apply to clerks, assistant chemists, designers, masters, and engineers, all of whom are short about 500 calories per day. Still more difficult is the situation of housewives, fed the basic ration but needing 800 work calories per day.

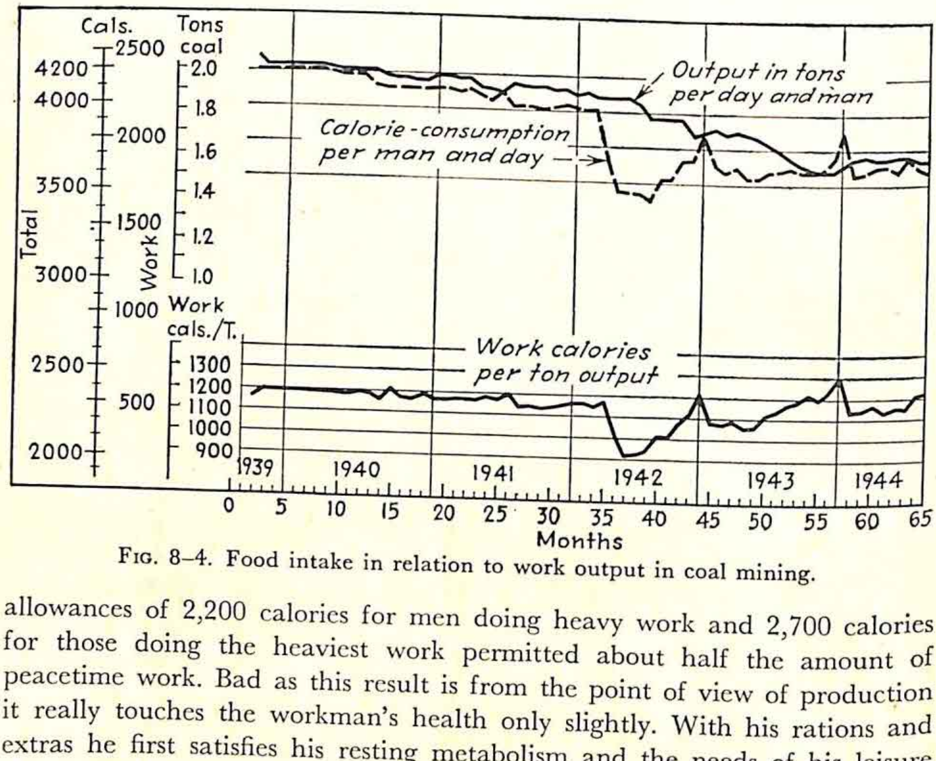

FIG. 8–4. Food intake in relation to work output in coal mining.

As a result of our observations it is clear that every professional activity requires a fixed amount of calories. No activity can be continuously greater than in accordance with the calorie intake; otherwise, loss of weight is induced, and this lowers the capacity, finally stopping work entirely. A regular control of body weight in industrial workers is, therefore, a good measure of their calorie supply. The output on varying rations is unthinkingly adapted to the available work calories by the worker himself, the body weight being kept constant.

Our results prove that rationing of food also means rationing of industrial production of a country. Control of production is diverted from management to those responsible for food administration, who often cannot see [that] the job of one man often has to be done by two or three men with a higher total wage cost.

Haggard and Greenberg[8] studied the relation of the frequency of food intake to muscular efficiency and the "respiration quotient" (which they found to be highly correlated with muscular efficiency). Spurts both of muscular efficiency and of the respiratory quotient came soon after each meal (about an hour after) and rapidly decreased to a base rate comparable to that of fasting. These results are shown in Figs. 8–5 and 8–6. The authors made no observations of subjective aspects, such as feelings of euphoria, during the study. The implication of this study is that workmen should eat more frequently during the workday.

Borsook[9] studied the relation of a daily vitamin food supplement to absenteeism, rate of termination, and merit ratings of aircraft workers during the recent war. An experimental group of workmen were given vitamin capsules 5 days a week for 1 year. A control group of workmen were given placebo capsules, of sodium bicarbonate colored and flavored to simulate vitamin capsules, for the same duration. A second control group did not participate in the study in any way but were checked to appraise the psychotherapeutic effect per se of the placebo on the control group. This group did not know that they were a part of the study. All three groups were "alike in age, duration of employment, and merit review scores." As the year progressed, the experimental or vitamin group became superior to the other two in every phase of comparison. There was a reduction in absences during the second 6 months of the year, which amounted to 18.6 per cent. Nonmilitary terminations were

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[8] Haggard, H. W., and Greenberg, L. A., *Diet and Physical Efficiency,* Yale University Press, New Haven, 1935.

[9] Borsook, H., Nutritional Status of Aircraft Workers in Southern California, III: Effects of Vitamin Supplementation on Absenteeism, Turnover, and Personnel Ratings, *Milbank Memorial Fund Quart.*, 1945, 23, 113–160.

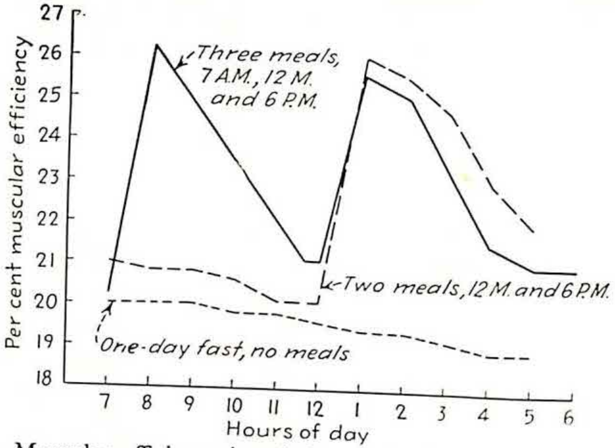

FIG. 8–5. Muscular efficiency in relation to the frequency of food intake.

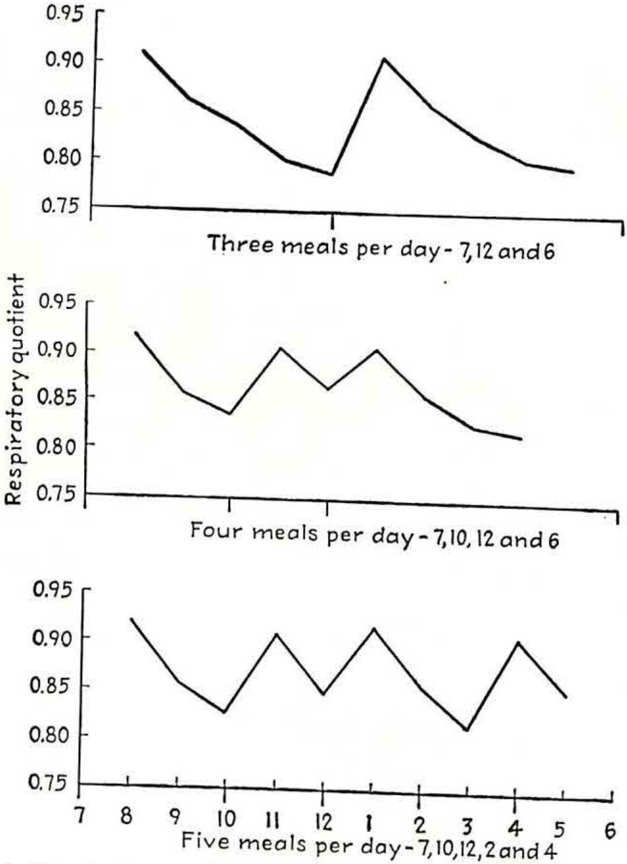

FIG. 8–6. Respiration quotient in relation to frequency of food intake.

reduced in the vitamin group 38 per cent, although this difference was of only borderline statistical significance. The merit-rating scores for the vitamin group increased during the year more than for the other groups. It was concluded that the over-all gain in production in the vitamin group was 10.5 working days per man per year. This is a tremendous gain when calculated for all workers for all war industries. Typical results from this study are shown in Tables 8–6 and 8–7 and Fig. 8–7.

TABLE 8–6. ABSENCE PER 100 MAN-DAYS FOR THREE GROUPS OF WORKMEN ON A SWING SHIFT

	Groups		
	Control	Placebo	Vitamin
Unauthorized	1.506	1.491	1.192
Illness	2.987	1.887	1.920
Authorized	0.844	0.595	0.550
Total	5.337	3.973	3.662

TABLE 8–7. INITIAL AND FINAL MERIT-RATING SCORES FOR THREE GROUPS OF WORKMEN ON A SWING SHIFT

	Groups		
	Control (*N* 165)	Placebo (*N* 156)	Vitamin (*N* 128)
Initial	5.638	5.672	5.693
Final	6.312	6.315	6.527
Gain	0.674	0.643	0.834

From these data, typical of others that could be reported, it is perhaps sufficiently evident that food is a very important factor affecting the efficiency of industrial workers. The problem now is: What can be done about it? The following pages will first discuss the nature of proper diets, and second, methods of inducing workmen to eat the prescribed foods.

PROPER DIET

As suggested above, a proper diet is one which provides a base of 1800 Cal. per day plus the work calories necessary for the activities performed. It should contain 10 to 15 per cent proteins, 60 to 75 per cent carbohydrates, and 15 to 25 per cent fats. There should be at least 3,000 international units of vitamin A, 300 units of vitamin B_1, 1,000 units of vitamin C, 500 of D, 450 of G (or B_2), and 15 mg. of P-P (nicotinic acid). An adequate amount (70 kg.) of the various minerals is also characteristic of a proper diet.

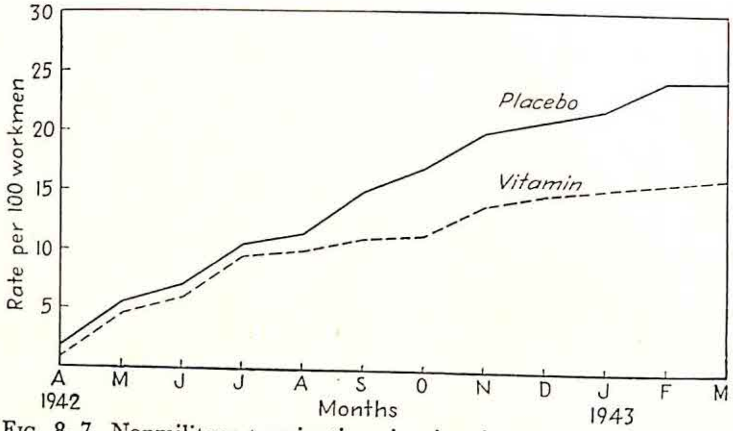

FIG. 8–7. Nonmilitary terminations in vitamin and placebo groups.

A simple plan for obtaining the essential nutritional requirements for an adult is to select foods as follows:

Milk—at least 1 pt. daily.

Eggs—at least one per day.

Meat—one serving per day with some fat.

Vegetables—potatoes and one or two cooked vegetables, leafy or green vegetables cooked or in salads, and limited amounts of raw vegetables for vitamin C and roughage.

Fruits—one or more servings daily. Include citrus fruit at least once per day.

Other foods—select according to taste.

In Miss Weihl's study (data reported in Figs. 8–1 and 8–2), a satisfactory diet was considered to consist of foods in weekly amounts as follows:

Milk—10 or more glasses.

Vegetables—green or yellow—six or more servings.

Citrus fruit and tomato—seven or more servings.

Eggs—four or more.

Lean meat, fish, or poultry—five or more times.

The U.S. Department of Agriculture[10] has listed "seven basic food groups" which should be represented in the daily diet of every workman. These are as follows:

Group 1—green and yellow vegetables (raw, cooked, frozen, or canned).

Group 2—oranges, tomatoes, grapefruit, raw cabbage, salad greens.

Group 3—potatoes and other vegetables and fruits (raw, dried, cooked, frozen, or canned).

Group 4—milk and milk products: fluid, evaporated, dried, or cheese.

Group 5—meat, poultry, fish, or eggs, or dry beans or peas, nuts, or peanut butter.

Group 6—bread, flour, or cereal—natural whole grain or enriched or restored.

Group 7—butter or fortified margarine.

Specific menus involving these essential foods are too many and varied to be discussed here. Needless to say, quality is equally as important as quantity in the preparation of food. Food must be well-prepared and attractively served.

Because of the constant fluctuation of food prices and the variable occupational food needs it is impossible to recommend a fixed per cent of a food budget to be spent for the various types of food. A division of the food budget commonly recommended, and appropriate for certain families of adults at certain times, is as follows:

One-fifth for vegetables and fruit.
One-fifth for milk and cheese.
One-fifth for meats, fish, and eggs.
One-fifth for bread and cereals.
One-fifth for sugar and other food supplements.

A good rule is to spend as much for dairy products as for meats, and as much for fruits and vegetables as for dairy products. The amount spent on other foods (bakery products, cereals, etc.) will then vary with individual tastes and necessities. This may be two-fifths of the budget, as above, or some other proportion.

INSTITUTING NUTRITIONAL PROGRAMS

It is one thing for industrial management to appreciate the importance of a proper nutritional program, but it is quite a different thing to get workmen to eat the proper kind of foods. Food preferences learned in youth are difficult to reform. Workmen prefer to eat only certain foods and their wives prefer to prepare only certain foods. If green salads, for example, have never been a part of the regular menus of a family, it is difficult to get the wife to prepare them and to get the husband to eat them even when prepared. Home nutritional patterns are not easy to reform.

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[10] Goodhart, R. S., *Industrial Feeding Management,* U.S. Department of Agriculture, War Food Administration, April, Washington, D.C., 1945.

There are two avenues of approach in instituting good nutritional programs—in-plant training and practice, and home and community training and practice.

Educating Workmen in Nutrition. Perhaps the beginning of all reform in nutrition should be in the various food dispensaries within the plant. Snack wagons, snack counters, canteens, package lunches, cafeterias, and mess halls should dispense only foods of nutritional value. Food-service managers should be trained in the basic principles of dietetics and practice them in the selection, preparation, and preservation of foods. Proper food should at least be available for those workmen who desire it.

At the same time, an in-plant program of education in nutrition should be conducted. This may be done by posters, lectures, pamphlets, exhibitions, and formal classes. The nutritional values of various foods are sometimes printed on menus and food price lists. Large companies often publish nutrition information in their house organs. One company with a cafeteria held a "menu contest." Each week the man who chose the most balanced menus was given a prize and ceremoniously entertained. Others with "honorable mention" were given lesser prizes. In a year's time, trays of good food selection increased from 23 per cent to 52 per cent. In another company where food education was emphasized, the consumption of salads increased 51 per cent, of milk 22 per cent, and of fruits 11 per cent. Programs of in-plant food education obviously can be made effective.

Educating Workers' Wives in Nutrition. The most effective method of training the workman's wife in nutrition is in a class which meets at least six times. This enables her to learn how to buy, how to prepare, and how to preserve good food, as well as why these things are important. Some companies conduct such classes as semiclubs, and try to make them entertaining as well as educational. Husbands and families are periodically entertained at dinners consisting of foods selected and prepared by the wives in accordance with the nutritional information which they are obtaining in class. The instructor in the class is often the company food-service manager or one of his assistants.

Often a company will secure the cooperation of local service companies in conducting a nutritional program. The local gas company and local grocery store are usually anxious to assist in any sort of nutritional education. In larger population centers, the gas company may employ a nutritional expert just for such services.

Educational literature on nutrition is available from the U.S. Department of Agriculture, the U.S. Public Health Service, the National Research Council—all in Washington, D.C. Publications may be obtained also from the following sources:

American Institute of Banking, 10 Rockefeller Plaza, New York.
American Meat Institute, 59 E. Van Buren St., Chicago.
American Red Cross, 17th and D Sts., N.W., Washington 13, D.C.
Evaporated Milk Assn., 307 N. Michigan Ave., Chicago.
H. J. Heinz Co., Pittsburgh.
Metropolitan Life Insurance Co., New York.
National Association of Manufacturers, 14 West 49th St., New York.
National Livestock and Meat Board, 407 S. Dearborn St., Chicago.
Servel Inc., Evansville, Ind.
Westinghouse Electric Corporation, Mansfield, Ohio.

REST

Rest is functionally defined as a period of recovery from the effects of work. It may be in the form of a change of activity, or of cessation of activity, or of sleep. Whatever its nature, having had it the individual is able to perform more work than would be possible without it. Rest periods range from short intervals during work, called "rest pauses," to the 16-hour intervals between workdays, to vacation periods of 2 weeks or more.

There are two fundamental aspects of the rest problem, one dealing with its duration and the other with its content. How long should rest periods be? What should be done while resting? These will be discussed in relation to the continuous work span, the workday, the workweek, and the workyear.

REST DURING WORK

It has been found that men rest during a workday whether the rest period is authorized or not. Vernon[11] reported years ago that men rest according to the difficulty of the work being performed. "The more arduous the work the longer the rests. In the heavy work of loading pitch, the rest periods amount to 22–26 minutes per hour, and in rolling tin plates they amount to from 14–28 minutes per hour." Workmen in agriculture rest on an average of 10.3 minutes per hour; in roadmaking, 10.9 minutes per hour; in bricklaying, 11.1 minutes per hour; in dock work, 11.2 minutes per hour; and in shoemaking 2.9 minutes per hour. The length of unauthorized rest periods is also related to the length of the workday. Men in a tin-plate mill (all jobs) rest an average of 10.2 minutes per hour when working on 6-hour shifts, but they average 12.5 minutes' rest per hour when on 8-hour shifts.

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[11] Vernon, H. M., Bedford, T., and Warner, C. G., Rest Pauses in Heavy and Moderate Heavy Industrial Work, *Indust. Fat. Res. Bd. Rept.*, No. 4, London, 1927.

A careful study was made by McGehee and Owen[12] of unauthorized rest periods by comptometer operators both before and after the introduction of authorized rest periods. The 16 female subjects worked five 7-hour days per week and had a 45-minute lunch period. For 2 weeks a careful record was kept of the duration of unauthorized rest when the girls actually left the workroom and of the amount of production. Then a 7-minute authorized rest period was introduced in midmorning and an 8-minute period in midafternoon, during which refreshments could be brought into the workroom. This time (15 minutes) was added to the length of the workday. After a week of adjustment, a record was again kept for 2 weeks of the time spent in unauthorized rest and also of the amount of production. A summary of the results is given in Table 8–8. Note that the differences were unquestionable as indicated by the size of the critical ratios. The decrease in unauthorized rest was 60 per cent and the increase in production was 29 per cent.

TABLE 8–8. UNAUTHORIZED REST AND PRODUCTION BEFORE AND AFTER THE INTRODUCTION OF AUTHORIZED REST PERIODS

	Unauthorized rest		Production	
	Before	After	Before	After
Mean	3.01	1.21	20.38	26.19
S.D.	0.71	0.83	7.34	8.78
$S.D._m$	0.18	0.21	1.90	2.27
Diff.	....	1.80	.....	5.81
$S.D._{diff.}$		0.20		0.98
C.R.		9.00		5.92

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[12] McGehee, W., and Owen, E. B., Authorized and Unauthorized Rest Pauses in Clerical Work, *J. Appl. Psychol.*, 1940, **24**, 604–615.

Vernon and Bedford (in the study referred to above) found that a 10-minute rest period in the middle of the morning increased the hourly production of girls on a labeling job by 20 per cent, yet reduced their working time only 2 per cent. In another study, the same authors found that girls assembling bicycle chains increased production 13 per cent per hour when a 5-minute rest period was introduced each hour.

Many companies have instituted authorized rest periods. The Woodward Governor Company (Rockford, Ill.) has a 10-minute rest period in the morning and another in the afternoon, during which music is played and refreshments may be obtained. The American Oil Company (Baltimore, Md.) has two daily rest periods—10:30 to 10:40 A.M. and 3:30 to 3:40 P.M.—during which the windows are all opened and the premises thoroughly ventilated. Many life-insurance companies have authorized rest periods for their clerical help. Reports from management indicate that they are satisfactory. "We consider the rest periods to be of definite benefit." "The rest periods seem to refresh our employees and enable them to carry out their duties more satisfactorily." "Our employees would not give up their rest periods, even if it meant lengthening the workday."

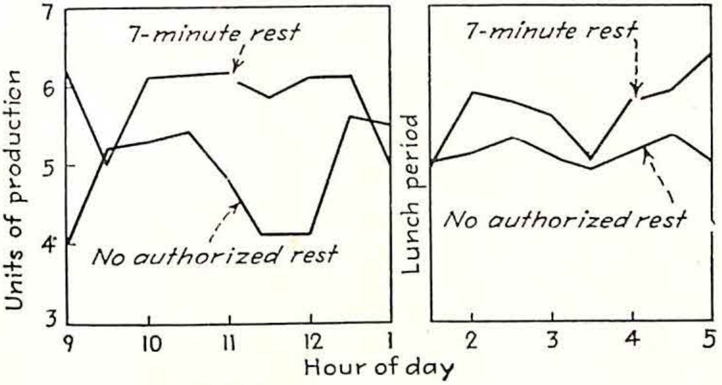

FIG. 8–8. Effects of authorized rest on production.

The effects of rest periods are illustrated in Fig. 8–8. Note that the morning rest period is located properly, but the P.M. period probably would have been more effective if it had been located at 2:30 or 3:00 instead of at 4 P.M.[13] It is generally recommended that rest pauses be placed just before the beginning of a production drop. Viteles[14] quotes a German study (by Richter) which indicates that while six 3-minute rest pauses increased production 11 per cent in a simple machine operation, three 8-minute rest pauses reduced production almost 6 per cent. Evidently the effectiveness of rest pauses depends on their location and length as well as on the nature of the work performed. Viteles suggests from a study of Shepard's findings[15] that workmen themselves are able "after instructions and experience to select the most satisfactory work and rest periods under the guidance of their own feelings." However, Tiffin believes that "it is more satisfactory for management to decide upon the proper amount and distribution of rest periods and then formally allow these rests." This conclusion is justified by Pressey's interpretation[16] of data taken from studies of moving pig iron. Men moved 16 pieces of pig iron per hour when they set their own pace; 18 pieces per hour when 25 minutes of work were followed by 5 minutes of rest; 22 pieces per hour when 17 minutes of work were followed by 3 minutes of rest; and 25 pieces per hour when 10 minutes of work were followed by 2 minutes of rest.

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[13] Figure from Tiffin, J., *Industrial Psychology,* p. 412, Prentice-Hall, Inc., New York, 1947, drawn from data by Farmer, E., and Bevington, S. M., An Experiment in the Introduction of Rest Pauses, *J. Nat. Inst. Industr. Psychol.,* 1922, 89–92.

[14] Viteles, M. S., *Industrial Psychology,* p. 480, W. W. Norton & Company, New York, 1932.

The content of the rest period is also important. Wyatt[17] found that when the rest period was spent in complete relaxation there was a gain in production of 9.3 per cent, when music was played there was a gain of 3.9 per cent, and when the workmen walked around there was a gain of only 1.5 per cent. Mayo[18] recommends that workers spend rest periods in as complete relaxation as possible. Workmen should sit down and, if possible, lie down during this period.

REST BETWEEN WORKDAYS

The amount of rest between working days depends on the length of the workday. When workdays are long, the intervening rest time is correspondingly short. When workdays are short, the intervening rest time is inversely long. The following pages will discuss the length of the workday rather than the reciprocal overnight rest period.

In 1890, the steel industry worked men 12 hours per day for 7 days per week. Fifty years later the same industry worked men 8 hours per day for 5 days per week. The 8-hour day has become the standard throughout American industry—and with research justification. Goldmark and Hopkins[19] reported a comparative study of production in two manufacturing plants equivalent in all respects except that the men in one plant worked 10-hour days, while the men in the other worked 8-hour days. The average output per day was 90.3 per cent of the maximum in the 10-hour-day plant and 94 per cent of the maximum in the 8-hour-day plant. The daily production curves are shown in Fig. 8–9.

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[15] Shepard, G. H., Effect of Rest Periods on Production, *Person. J.*, 1928, **7**, 186–202.

[16] Pressey, S. L., *et al.*, *Life: A Psychological Survey*, p. 524, Harper & Brothers New York, 1939.

[17] Wyatt, S., Rest Pauses in Industry, *Industr. Fat. Res. Bd. Rept.*, No. 42, London, 1927, pp. 1–3.

[18] Mayo, E., Revery and Industrial Fatigue, *J. Person. Res.*, 1924, **5**, 273–281.

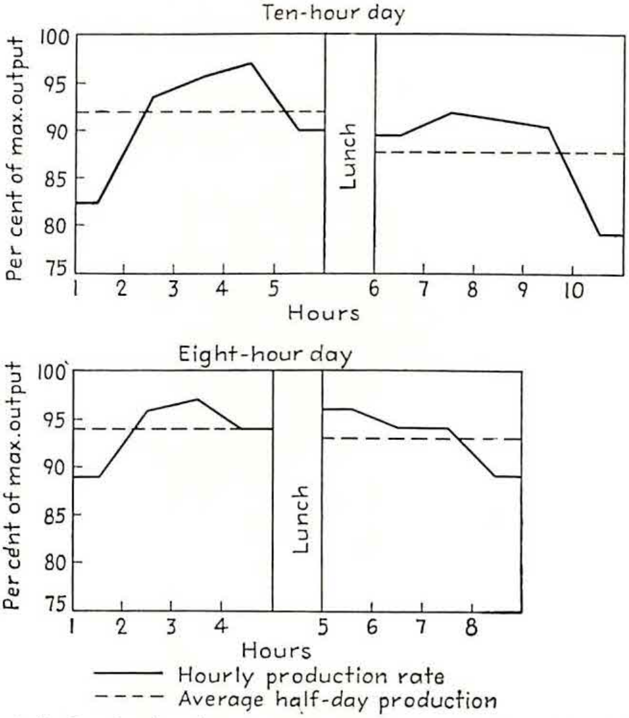

FIG. 8–9. Production in 10-hour-day plant and 8-hour-day plant.

A more recent study of the relation of production to the length of the work day was made by Kossoris of the U.S. Bureau of Labor Statistics.[20] He found that the 7½-hour day is better than the 9½-hour day when judged both by hourly production and by absenteeism. The production is higher for the shorter workday and the absentee rate is lower. These results are shown in Fig. 8–10.

[19] Goldmark, J., and Hopkins, M. D., Comparison of an Eight Hour Plant and a Ten Hour Plant, *U.S. Publ. Hlth. Serv. Bull.*, No. 106, 1920.

[20] Kossoris, M. D., Studies in the Effects of Long Working Hours, *Bur. Labor Stat. Bull.*, No. 791, 1944.

While the 8-hour day seems to be better than longer periods, there is some evidence that it is also better than shorter work periods. Best[21] surveyed the opinion of two separate groups of workmen who had experience on both 6- and 8-hour shifts. Her results are shown in Table 8–9. However, a study of production in tin-plate mills in England showed that when days were reduced from 8- to 6-hour shifts, hourly production increased 10 per cent; when 8-hour shifts were reduced to 4 hours, there was an increase of 11.5 per cent in hourly production.

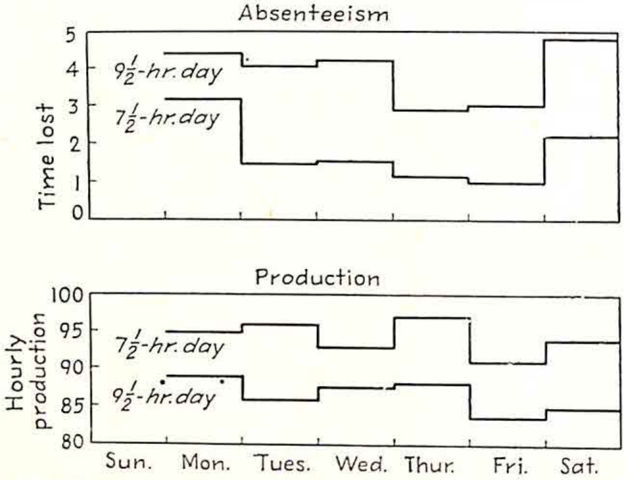

FIG. 8–10. Effects of length of workday on absenteeism and production.

TABLE 8–9. FEELINGS OF FATIGUE AFTER 6-HOUR DAY AS COMPARED WITH 8-HOUR DAY

	Per cent reporting 6-hour day		
	Less fatiguing	The same	More fatiguing
Survey I (*N* 265)	25.2	56.1	18.7
Survey II (*N* 282)	23.0	42.5	35.5
Total	24.1	49.3	27.1

REST BETWEEN WEEKS

Closely associated with the length of the workday is the length of the workweek. Evidence seems to support the conclusion that the 8-hour day and the 5-day week is the best combination for the highest production per man hour. Pressey[22] shows in a graph (see Fig. 8–11) drawn from data of the records of production in a box factory that the 40-hour week is better than both longer and shorter weeks. This is substantiated by other studies both in this country and in England. The British learned during the Second World War that the average weekly output for a 75-hour week was approximately the same as for a 64-hour week, and that the output for a 55-hour week was actually 13 per cent higher than for the longer weeks.[23] After the Dunkirk debacle in the Second World War, the British increased the workweek to 7 days and 84 hours per week. For a short time (2 months) they found that production increased, but it then dropped off and became even less than under the shorter workweek. Sickness increased, the accident rate rose, and absenteeism became a major problem. Mr. Bevin stated on July 30, 1940, that "experience in manufacturing fields points to 55 to 56 hours being the optimum hours of a working week." It was also found that there should be at least one complete day off during each week. A seven-day workweek was not economical. It was concluded by the Minister of Supplies that "neither in the interests of the workers

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[21] Best, E. L., *U.S. Dept. Labor Rept.*, No. 105, 1933; No. 116, 1934.

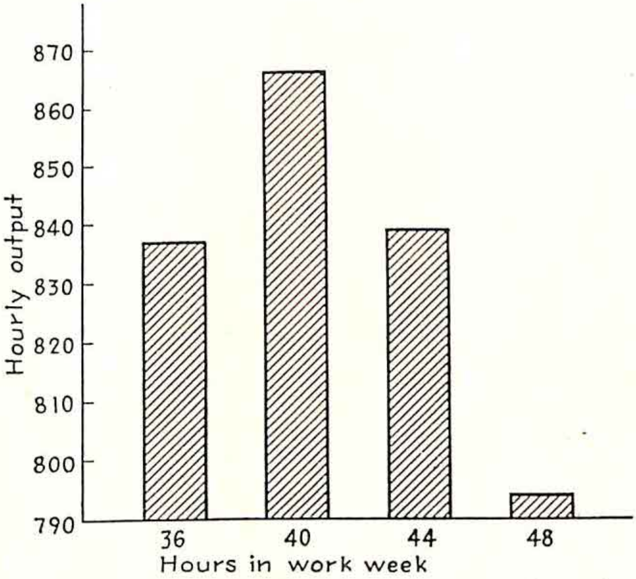

FIG. 8–11. Effects of varied lengths of work week on hourly production in a box factory.

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[22] Pressey, *loc. cit.*

[23] See Kossoris, M. D., Hours and Efficiency in British Industry, *Mont. Labor Rev.*, 1941, 52, 1337–1346.

themselves nor in the interests of maximum output can a week of seven days be worked indefinitely."

The effects of a 60-hour workweek in comparison with a 40-hour workweek in American metal industries was studied by Kossoris.[24] In one plant producing 105-mm. shells during the Second World War, he found that, while the actual hours of work increased 42.5 per cent,[25] there was a corresponding increase in total weekly production of only 5.5 per cent (see Fig. 8–12). The hourly production (efficiency) dropped off 22.3 per cent and the accident rate doubled. The same investigator found comparable results in a survey of 12 other metalworking plants. He concludes that "the available evidence indicates that, on the whole, the five-day week and eight-hour day are more efficient than a work schedule with longer hours."

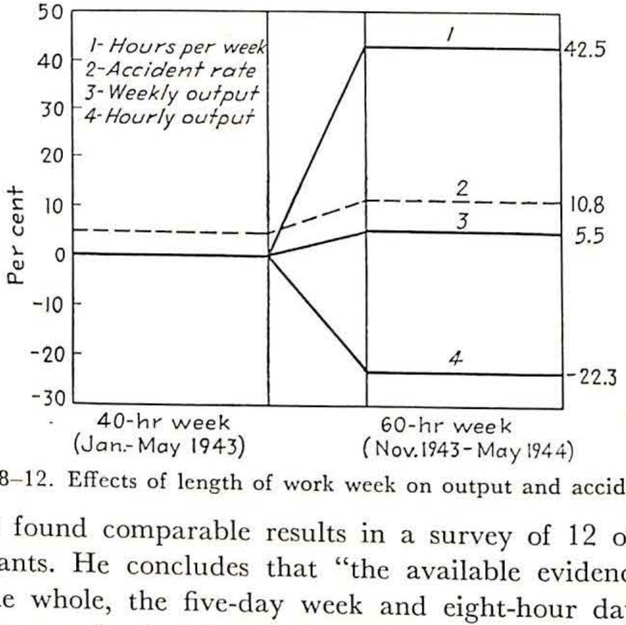

FIG. 8–12. Effects of length of work week on output and accidents.

YEARLY REST PERIODS (VACATIONS)

Prior to 1937, provision for vacations was included as a clause in the union contract of only 4 per cent of the companies surveyed by the National Industrial Conference Board that year.[26] In 1946, more than 88 per cent of the companies surveyed provided for formal vacations in their union contracts. Of 305 U.S. and Canadian companies surveyed (both union and nonunion), 92.4 per cent of them provided vacations for their wage earners and only two (Canadian) companies did not provide for vacations for their salaried workers. The results of this survey are shown in Table 8–10.

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[24] Kossoris, Studies in the Effects of Long Working Hours.

[25] There was more time lost in unauthorized rest during the longer work week.

[26] Most of the following data concerning vacations came from *Studies in Personnel Policy*, Nos. 56 and 75.

TABLE 8–10. UNITED STATES AND CANADIAN COMPANIES WITH DEFINITE VACATION PLANS

Survey	With vacation plan	Per cent	Without vacation plan	No wage earners employed
United States (*N* 254):				
Wage earners	236	92.9	4	14
Salaried workers	254	100		
Canadian (*N* 51):				
Wage earners	46	90.2	2	3
Salaried workers	49	96.1	2	

There are two major types of vacation plans—uniform and graduated. In the uniform plan, all employees who have been with the company a predetermined length of time are allowed vacations of uniform length. Older employees (in length of service) receive no more vacation than younger employees who have met the preliminary vacation service requirements. In the graduated type of vacation, employees who have met the minimum service requirements are granted vacations varying in length with the years of service. A man with 1 year's service may get a week's vacation, another with 5 years' service may get 2 weeks, and another with 10 years' service may get 3 weeks. A few companies grant as much as 4 weeks' vacation for 25 years' service.

Some companies (about 65 per cent) stagger vacations and operate with a reduced staff during the vacation months, usually August and September. Other companies (about 20 per cent) close down completely while the entire personnel is on vacation. Most companies pay the usual wages during vacation (paid in advance) but some grant vacation bonuses. During the war, many companies paid men double for working during their vacation periods; that is, they were given vacation allowances in addition to regular pay.

The author was unable to find any study of the actual value of vacations in increased production, or improved worker morale, or reduced ill health. Walters[27] makes the statement that "many managements have found that one or two weeks' vacation for employees has increased production during the year sufficiently to make up for the two per cent of the year's wages for each week of vacation, as well as the loss of production during vacation." Whether or not this opinion is justified by an unreported study is unknown. Certainly the trend is toward longer vacations for a greater number of people whether or not it is justified by research data.

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[27] Walters, J. E., *Personnel Relations*, p. 120, The Ronald Press Company, New York, 1945.

SUMMARY

It is estimated that 90 per cent of absences from work in American industry are due to sickness and that much of this is preventable.[28] Good health is dependent on many factors. Two of them—nutrition and rest—are of major importance and can be controlled in large degree by any typical industry. Studies of the importance and of the effects of control of these two factors are reviewed in this chapter. *Nutrition* was considered so important to the employee's efficiency that the Jack and Heintz Company in Cleveland served, free of charge, "a hot, well-balanced meal to each shift once a day" during the recent war. They also served with the meal "capsules containing a well-balanced vitamin preparation." Other companies have similar programs, although the employee is usually charged for the food. *Rest* during work has received too little attention in American industry although the optimum length of the workday and of the workweek has been carefully studied. It is important to note that rest is recognized as an important factor in the maintenance of the workingman's efficiency. Scientific ways and means of controlling this factor will soon follow this recognition of its importance.

RECOMMENDED READINGS

Aspley, J. C., and Whitmore, E.: *Industrial Relations,* Secs. 32, 36, and 37, The Dartnell Corporation, Chicago, 1943.

National Research Council: *Fatigue of Workers,* Reinhold Publishing Corporation, New York, 1941.

Roethlisberger, F. J., and Dickson, W. J.: *Management and the Worker,* Harvard University Press, Cambridge, 1939.

Sherman, H. C.: *Chemistry of Food and Nutrition* (6th ed.), The Macmillan Company, New York, 1941.

Vernon, H. M.: *Industrial Fatigue and Efficiency,* E. P. Dutton & Co., New York, 1921.

Wampler, F. J.: *Industrial Medicine,* Chap. 25, The Williams & Wilkins Company, Baltimore, 1943.

Weihl, Dorothy G., Borsook, H., *et al.: Nutritional Status of Aircraft Workers in Southern California,* Milbank Memorial Fund, New York, 1942–1946.

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[28] Aspley, J. C., and Whitmore, E., *Handbook of Industrial Relations,* p. 755, The Dartnell Corporation, Chicago, 1943.

Chapter 9

SAFETY

- Accident Proneness
  - Factors Affecting Accident Proneness
    - Age
    - Experience
    - Attitudes
    - Emotional Stability
    - Vision
    - Other Factors
  - Measuring Accident Proneness
    - Intelligence
    - Vision
    - Reaction Time
    - Perception-Dexterity Relationship
    - Test Batteries
- Accident Prevention
  - Safety Education
    - Training Foremen
    - Training Workmen
    - Safety Campaigns
  - Safe Working Conditions
    - Housekeeping
    - Machine Guarding
    - Lighting
    - Maintenance
- Summary

Accidents take more lives in the United States and cost more in dollars and cents than all our wars combined. Nearly 100,000 people are killed every year, over 10 million are injured, and the annual cost of accidents is more than 7 billion dollars. This means that 274 people are killed every day; 27,000 are injured; and the daily cost in wage loss, medical expense, property damage, etc., is almost 20 million dollars. Our total casualties in the Second World War were 261,608 killed and 684,722 wounded and missing. During the same time, 355,000 were killed in accidents in the United States and 36 million were injured. Accidents in our country are exceeded only by heart disease, cancer, and cerebral hemorrhage as a cause of death. Under the age of 35 they are the major cause of death.

The home is the major location of accidents. In 1948, 34,500 lost their lives in home accidents, 33,000 were killed in motor accidents, 16,500 were killed in public nontransportation and nonoccupational accidents, and an equal number of accidental deaths (16,500) occurred on the job or in occupational accidents. These data are shown in Fig. 9–1 in relation to the average accident rates for 9 years, 1938 to 1946.[1]

In this chapter our major concern is with the accidents that are classified as occupational. In 1948, there were 16,500 fatal occupational accidents and 1,950,000 injuries. The over-all cost of these, including damaged equipment and interrupted production schedules, was $2,600,000,000. This was a 3 per cent reduction from the 1947 record. The distribution of fatal accidents by major occupations is shown in Table 9–1.[2]

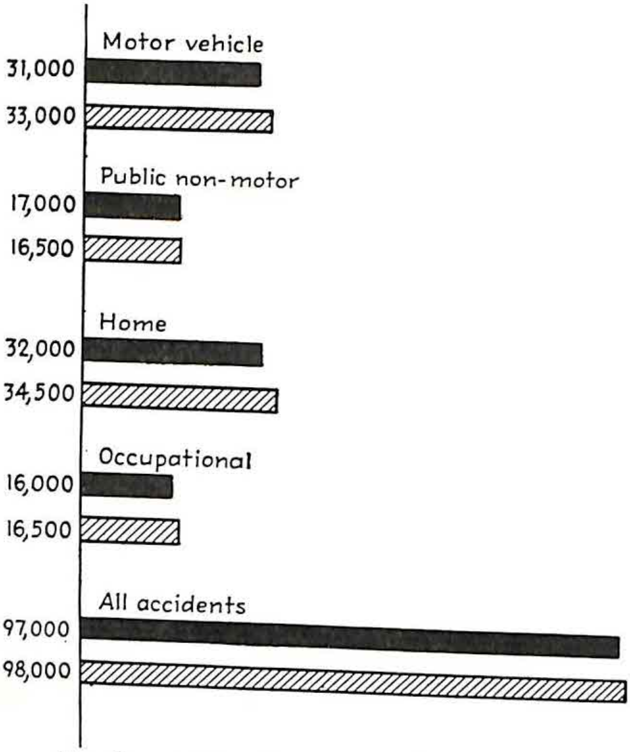

FIG. 9–1. Fatal accidents in the United States.

The sources of these accidents varied greatly with the occupation, but the over-all picture is shown in Table 9–2. One-fourth of all in-

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[1] These data are all taken from *Accident Facts*, handbooks published annually by the National Safety Council, Chicago.

[2] *Ibid.*, 1948.

TABLE 9-1. DISTRIBUTION OF FATAL ACCIDENTS BY MAJOR OCCUPATIONS, 1947

Occupation	No. of deaths	Ratio per 100,000 workers
Mining, quarrying, oil and gas wells	1,500	167
Construction	2,400	96
Transportation	1,700	53
Agriculture	4,300	52
Public utilities	400	31
Service	2,500	18
Manufacturing	2,700	17
Trade	1,500	15

TABLE 9-2. SOURCES OF OCCUPATIONAL DEATHS AND INJURIES

Cause of accident	Fatal and total disabilities, per cent	Temporary disabilities, per cent
Vehicles	23	8
Falling objects	18	11
Falls	16	19
Electricity, explosions	13	
Machinery	9	9
Handling objects	6	25
Hand tools	..	8
Other	15	20

juries occurred in handling materials and equipment, while one-fifth of them were due to falls

Accidents may be classified as those due to conditions over which man has no control—mechanical failures, weather, "acts of God," etc.—and those due to the human element over which man does have control. The exact per cents in each group are not known, but the latter far exceeds the former. Some safety engineers believe that four out of five accidents are due to human causes and others believe the ratio to be as high as nine out of ten. The National Safety Council estimates that only 18 per cent of industrial accidents are due to mechanical failures and therefore unpreventable. That means, for example, that 13,530 people were killed in 1948 in accidents caused by the occupational negligence and ineptitude of themselves or their own fellow workmen. If this percentage is approximately true in other types of accidents, and it probably is, it means that a million people are killed every 12 years in the United States through acts directly attributable to themselves and to other people.

Safety engineers have been very proficient in building guards to keep people away from dangerous machinery; in designing cars and airplanes that will travel at tremendous speeds without mechanical failure; in planning roadbeds through deep canyons and up mountainsides that are almost as free from danger as prairie highways; and in constructing flood dams that protect us from the very "acts of God." They have been able to control and avoid those "unpreventable accidents" and reduce their occurrence to an appreciable degree. However, they have been much less effective in reducing that great majority of accidents due to human frailty. This is due in part to the fact that the human element in accidents is a psychological one and safety engineers are not psychologists. While the psychologists have been too little concerned with this problem, they have made some studies which are significant. This chapter will review typical studies of this nature.

ACCIDENT PRONENESS

It is a well-known fact that some people have more accidents than others. Jurgensen[3] found in one company that 49 per cent of a group of employees had 94 per cent of the total number of accidents, 29 per cent had 80 per cent of the accidents, and 11 per cent had 50 per cent of the accidents. Slocombe[4] studied the factors involved in 2,651 accidents implicating 625 employees. He found that 908 accidents occurred to 442 employees (2.1 each) and 1,733 occurred to 183 employees (9.5 each). He calculated that 6 per cent of all employees had 65 per cent of all accidents.

Tiffin[5] studied the hospital visits (due to injuries) made by employees in a steel mill in 2 consecutive years, 1938 and 1939. He found that those who made frequent visits during 1938 also made frequent visits during 1939. This would suggest that some workmen have accidents that are due to their own "human frailty." Tiffin's data for this study are shown in Table 9–3.

Blum[6] warns that conclusions from such studies must be made with

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[3] Jurgensen, C. E., Accident Causes, *Nat. Safety News*, 1945, 52, No. 5.

[4] Slocombe, C. S., How to Cut Accident Costs, *Person. J.*, 1937, 16, 136–141.

[5] Tiffin, J., *Industrial Psychology*, p. 423, Prentice-Hall, Inc., New York, 1947.

[6] Blum, M. L., *Industrial Psychology and Its Social Foundations*, p. 285, Harper & Brothers, New York, 1949.

TABLE 9–3. FREQUENCY OF HOSPITAL VISITS BY SAME EMPLOYEES IN A STEEL MILL FOR 2 CONSECUTIVE YEARS

1938	1939
0	0.69
1	1.12
2	1.46
3	1.86
4	1.91
5	3.32
6	3.82
7	4.62
8	4.92
9	5.14

care. Chance is a factor here and must not be ignored. For example, if there are 1,000 employees in a company and there are 500 accidents during a given time and all these occurred by pure chance, they could occur to only 500 employees. Therefore, 50 per cent of the employees would account for 100 per cent of the accidents. If there were only 250 accidents, 25 per cent of the employees would account for 100 per cent of the accidents. Accident proneness really means that some employees have more accidents than would be expected on the basis of chance. If 500 accidents occur each year in a plant employing 1,000 men, there is a chance accident expectancy, then, for each man, of one accident every 2 years.

Another factor that affects the interpretation of accident data in calculating accident proneness is the variation in hazards between jobs. Some jobs are more dangerous than others and accident expectancy is greater. If the 10 per cent of employees who have 50 per cent of the accidents are working on jobs that are excessively dangerous, it is no indication of accident proneness. Accident proneness of one man is relative to that of other individuals when working factors are kept constant. Accident proneness is not only relative, but it exists in degree. The fact that workmen are human beings presupposes a certain amount of accident proneness. But one is not either accident prone or not accident prone. Rather, he is more accident prone or less accident prone than is the average individual in a particular situation with the same hazards.

FACTORS AFFECTING ACCIDENT PRONENESS

Accident-prone individuals (*i.e.,* those above average in this respect) may or may not be "born that way." If they are, it means that they are accident prone at all times. However, some individuals are accident prone at some times and not accident prone at other times, depending upon circumstances. They are made accident prone by affecting factors.

Age. A very obvious factor affecting accident proneness is age. Young people and old people are more accident prone than those in the mid-ages. For example, the traffic-accident death rate for 1947 was 30.9 (per 100,000 population) for ages 15 to 24, 21.1 for ages 25 to 44, 25.1 for ages 45 to 64, and 50.3 for ages over 65. In industry, there is not so much evidence of higher accident frequency on the younger age levels because few workmen are less than 20 years old. The severity of accidents at higher age levels is markedly above that at younger ages. Chaney and Hanna[7] found in an old study that the fatal accident rate in the steel industry for ages above 40 was 2.5, while that below 40 was only 1.7.

Other studies of the relation of age to accidents are reported in Chap. 12.

Experience. In industry, experience is more closely related to accident rate than is age. In an early study by Fisher,[8] it was found that the accident rate was inversely related to the amount of experience. This is shown in Table 9–4. The U.S. Bureau of Mines found that 48.1 per cent of accidents occurred in coal mines during the first 60 days of employment and 20.5 per cent occurred during the first 7 days. Vernon[9] found that the accident rate continues to decrease markedly with young workers in England up to 18 months after employment (see Fig. 9–2). This suggests that perhaps better training would help to reduce this rate more quickly.

TABLE 9–4. ACCIDENTS IN RELATION TO EXPERIENCE ON THE JOB

Length of Service	Accident Rate (% of Total)
Less than 1 month	181
1 to 3 months	127
3 to 8 months	87
8 to 12 months	62
1 to 5 years	57

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[7] Chaney, L. W., and Hanna, H. S., The Safety Movement in the Iron and Steel Industry, *Bur. Labor Stat. Rept.*, No. 234, 1918.

[8] Fisher, B., *Mental Causes of Accidents*, p. 34, Houghton Mifflin Company, Boston, 1922.

[9] Vernon, H. M., Prevention of Accidents, *Brit. J. Industr. Med.*, 1945, 2, 3.

Ghiselli and Brown[10] found a marked relation between accident rate and experience on the job *after* training for 60 streetcar motormen and 34 motor-coach operators. Their data are shown in Fig. 9–3. Obviously the training was not complete at the end of the formal training period.

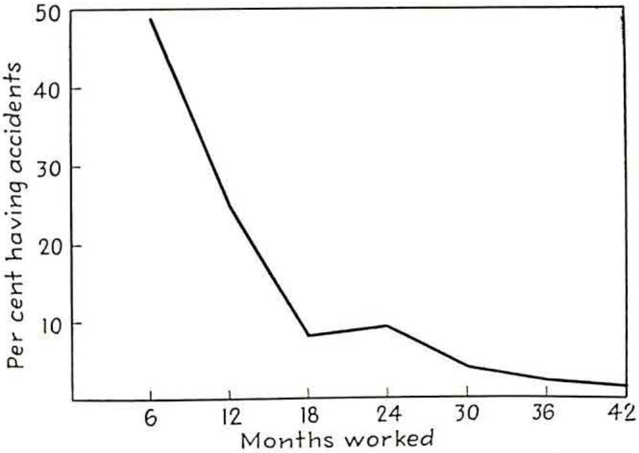

FIG. 9–2. Accidents in relation to experience on the job.

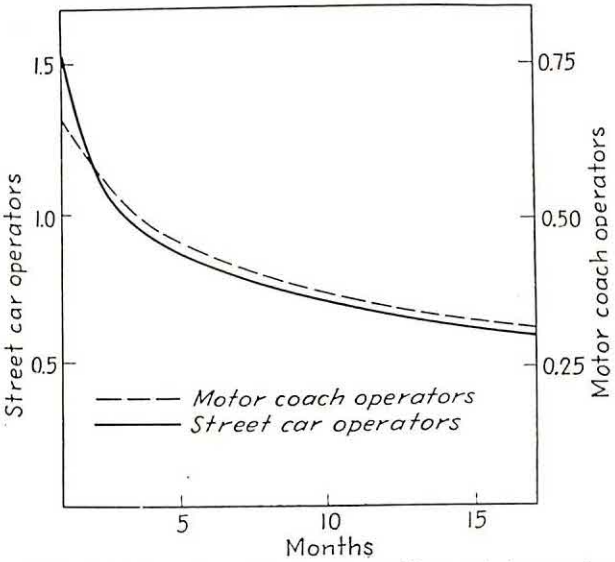

FIG. 9–3. Relation of accident rate to 17 months' experience.

It must be noted, however, that some studies show that the coefficient of correlation between experience and accident rate is very low. Some workmen realize the handicap of inexperience and are more careful because of it.

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[10] Ghiselli, E. E., and Brown, C. W., Learning in Accident Reduction, *J. Appl. Psychol.*, 1947, 31, 580–582.

Attitudes. It has been found that there is a relationship between accident frequency and the attitude of cooperation toward company rules and regulations, especially toward those dealing with safety. The "devil-may-care" attitude is more often associated with accidents than any other single factor. A study by the Metropolitan Life Insurance Company in 1930 (*The Accident Prone Employee*) of the causes of accidents in the Cleveland Street Railway Company showed that "faulty attitude" was the most frequent cause. These results are shown in Table 9–5. Bingham[11] found that 39 per cent of a group of high-accident-incidence employees of the Boston Elevated Railways Company were rated as "uncooperative," whereas only 5 per cent of a low-accident-incident group were so rated.

TABLE 9–5. PRIMARY CAUSES OF ACCIDENTS
(In per cent of total)

Faulty attitude	14
Failure to recognize potential hazards	12
Faulty judgment of speed or distance	12
Impulsiveness	10
Irresponsibility	8
Failing to keep attention constant	8
Nervousness and fear	6
Defective vision	4
Organic disease	4
Slow reaction	4
High blood pressure	2
Senility	2
Worry and depression	2
Fatigue	2
Improper distribution of attention	2
Inexperience	2
Miscellaneous	6

The causes of such uncooperative attitudes are as varied as the factors which affect men's lives. One man in a steel-fabricating plant who had a 3-year, no-accident record, had two accidents in a single week. It was later discovered that his wife had an advanced case of T.B., and he was unable to get her into the state sanitarium. Such instances have led some psychologists to believe that the clinical approach is important to the problem of accident prevention. Shellow[12] reports that 33 operators in a street railway company who had high accident records had 81 per cent fewer accidents in the 6 months following their clinical study than they had in the preceding 6 months. The clinical approach is even more useful in dealing with those individuals who are emotionally unadjusted.

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[11] Bingham, W. V., The Accident Prone Driver, *Hum. Factor,* 1932, 6, 158–169.

[12] Shellow, S. M., The Accident Clinic, How It Functions and What It Accomplishes, *Person, J.* 1930, 9, 207–215.

Emotional Stability. Hersey[13] found in a clinical study of 400 accidents that "more than half of them took place when the worker was worried, apprehensive, or in some other low emotional state." He estimated that due to home and job difficulties, fatigue, loss of sleep, etc., the average man is in a "low" emotional state about one-fifth of the time.

The data in Table 9–5 indicate that emotional factors account for approximately one-third of all accidents. Faulty attitudes, impulsiveness, nervousness and fear, worry and depression make up 32 per cent of the primary accident causes in the street railway company studied.

After an overhead crane operator had two minor accidents in one day, he confided to the writer that the night before, they were informed that his son had been wounded in the "Battle of the Bulge." All men are subject to states of emotion and while in those states they are accident prone. They become hazards no less dangerous than open gears and exposed high-tension wires.

Vision. Tiffin[14] found that those employees in a steel mill who met visual standards (except for color vision) had fewer accidents than those who did not. These data are shown in Table 9–6. Fletcher[15] found that a group of 200 "good" drivers (truck drivers and a class of highway patrolmen) were definitely superior to a group of "poor" drivers (who had had a fatal accident or three injury accidents) in three visual factors. These are shown in Table 9–7. The importance of normal vision on jobs where there are safety hazards would seem to be obvious. Tests and corrective procedure for vision are much easier to administer than for most other factors causing accident proneness.

TABLE 9–6. PER CENT OF EMPLOYEES HAVING LOST-TIME ACCIDENTS WHO DID AND DID NOT MEET VISUAL STANDARDS

Visual factor	Met visual standards	Failed to meet visual standards	Ratio
Acuity, far	1.09	1.37	1–1.26
Depth perception	1.23	1.57	1–1.28
Color vision	1.21	1.14	1–0.94
Phoria	1.26	1.82	1–1.44

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[13] Hersey, R. B., Emotional Factors in Accidents, *Person. J.* 1936, 15, 59–65.

[14] Tiffin, *op. cit.*, p. 433.

[15] Fletcher, E. D., Capacity of Special Tests to Measure Driving Ability, State of California, Department of Motor Vehicles.

TABLE 9-7. PER CENT OF GOOD DRIVERS AND POOR DRIVERS FAILING TESTS ON THREE VISUAL FACTORS

Visual factor	Good drivers	Poor drivers	Difference	Critical ratio
Glare sensitivity	3.5	24.0	20.5	7.5
Astigmatism:				
Left eye	31.8	45.8	14.0	3.3
Right eye	25.5	41.1	15.6	3.8
Acuity:				
Both eyes	1.0	5.0	4.0	2.9
Left eye	7.0	21.8	14.8	5.1
Right eye	7.5	15.3	7.8	2.9

Other Factors. Accidents are affected by the *temperature* of the working environment. Osborne and Vernon[16] found that there are fewer accidents among factory workers when the temperature is near 70°. The rate is considerably higher when the temperature is below 65 or above 75°. This is likewise true of the severity of accidents. The amount of lost time is greater for accidents occurring in the higher and lower temperatures. Figure 9-4 shows some of the Osborne-Vernon data.

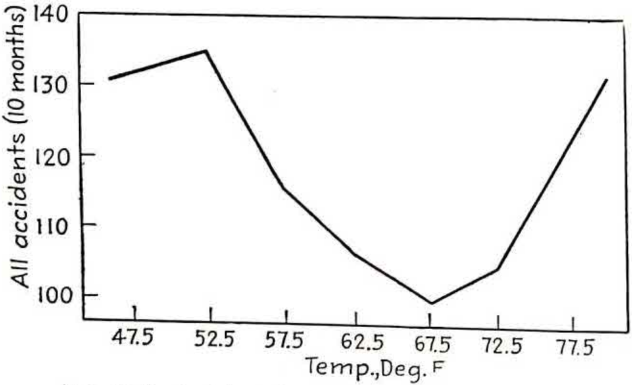

FIG. 9-4. Accident frequency and temperature.

Another important factor in accident causation is poor *illumination*. Fewer accidents occur in daylight than in any kind of artificial illumination. After a survey, the Travelers' Insurance Company estimated that 24 per cent of all accidents were due to poor lighting. In a survey in Great Britain, it was found that artificial lighting caused an over-all increase in accidents of 25 per cent, and an increase of accidents involving falls of 74 per cent.[17] Around docks and shipyards, accidents due to persons falling more than doubled. It should be noted that these studies were made with the old incandescent direct lights in use. Newer types of lighting fixtures, greater light diffusion, and greater light intensity would certainly change the above accident data.

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[16] Osborne, E. G., and Vernon, H. M., Contributions to the Study of Accident Causation, *Industr. Fat. Res. Bd. Rept.*, No. 19, London, 1922.

Workmen are more accident prone when they are under the influence of *alcohol.* This fact is so obvious that many industries refuse to allow a man to go on the job if he has been drinking. Alcohol is a depressant and reduces both sensory and motor functions. This is especially true when movements requiring the coordination of various parts of the body are involved. Miles[18] found that, while speed in typewriting was reduced only 3 per cent by the use of alcohol, accuracy was reduced 40 per cent after small drinks and 70 per cent after larger drinks. In an old study quoted by Vernon,[19] chronic drinkers were found to have three times as many accidents as nondrinkers. The National Safety Council found that, in 1947, 19 per cent of the drivers and 24 per cent of the pedestrians involved in fatal accidents had been drinking.

Another factor affecting accident proneness is the *rate of production.* The faster a man works the less careful he is of avoiding dangers. Consequently, he is in an increased number of accidents, and they are of increased severity. The accident rate tends to follow the production rate for both morning and afternoon. Of course, *fatigue* is another factor which may explain part of the increased accident rate. Obviously, the workman becomes more and more fatigued with increased production rate. However, during the last hour in the morning, just before the lunch hour, the production rate drops off, and this change of pace is usually accompanied by a corresponding drop in the accident rate. If fatigue were a very significant factor, the accident rate could be expected to continue here because fatigue is certainly not diminished at this time. A typical accident frequency curve in relation to a production curve is shown in Fig. 9–5.

Rate of production and fatigue as causes of accident proneness are tied in with the *length of the work period.* In general, accidents increase with the length of the work period, beyond an optimum length, unless the rate of production decreases. In other words, each of these three

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[17] As reported by Vernon, H. M., *Accidents and Their Prevention,* p. 85, The Macmillan Company, New York, 1936.

[18] Miles, W. R., Alcohol and Human Efficiency, *Carnegie Instn. Publ.,* No. 333, 1924.

[19] Vernon *Accidents and Their Prevention,* p. 70.

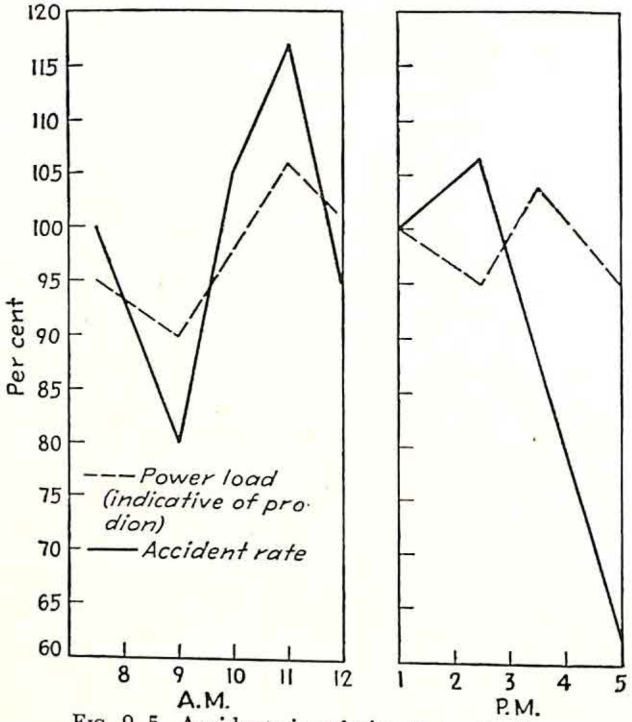

FIG. 9–5. Accidents in relation to production.

factors alone, with the other two held constant will increase accident proneness. In a work situation, however, it is impossible to prevent fatigue when the rate of production is stepped up, and it is impossible to keep up the rate of production when the length of the workday or the length of the workweek is increased. Goldmark[20] and his associates studied the relation of accidents to the length of the workday with the production unit held constant. These data are shown in Fig. 9–6. The accident rate for various hours in the workday is shown in Fig. 9–7.

MEASURING ACCIDENT PRONENESS

It is obviously important to discover accident-prone workmen before they have had an accident and place them on jobs that are relatively safe. It is even more important to identify this trait in workmen before they are hired and to employ only those who are the less accident prone. Various sorts of tests have been used to measure symptoms of accident proneness.

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[20] Goldmark, *et al.*, Studies in Industrial Physiology, *U.S. Publ. Hlth. Serv. Bull.*, No. 106, 1920.

Intelligence Tests. Lauer[21] found that automobile drivers who have I.Q.'s below 75 are very liable to have accidents. Another study showed that 69 per cent of those who appeared in a traffic court had below-average intelligence. However, the relation of intelligence to accident liability in industry is not so clear. Farmer and Chambers[22] found but little relation between accident rates of carpenters, fitters, and dockyard apprentices and the scores they made on intelligence tests. The correlations were .01, .08, and .13, respectively. On the other hand, Schaefer[23] reported that the average yearly accident rate per 100 workers of those who scored high on an intelligence test (A and B) was .89,

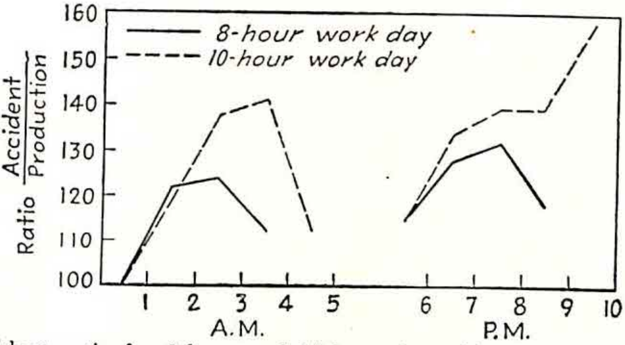

FIG. 9–6. Accident ratio for 8-hour and 10-hour day with production rate constant.

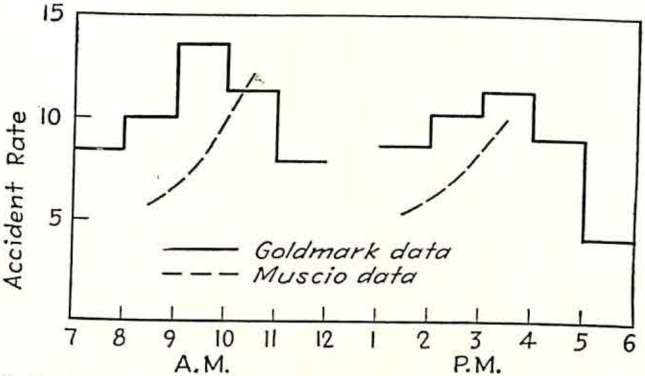

FIG. 9–7. Accident frequency during workday (in per cent of total).

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[21] Lauer, A. R., What Type of Persons Have Accidents? *Nat. Safety News*, 1932, 25, 16–17.

[22] Farmer, E., and Chambers, E. G., A Study of Personal Qualities in Accident Proneness and Proficiency, *Industr. Hlth. Res. Bd. Rept.*, No. 55, London, 1929.

[23] Schaefer, Vernon G., *Safety Supervision*, p. 192, McGraw-Hill Book Company, Inc., New York, 1941.

while the corresponding rate for those who scored low (D and E) was 2.42.

The relation of intelligence to accidents obviously depends on the complexity of the situation in which the accident occurs. The performance even of unskilled work in a maze of hazards requires a higher level of intelligence to avoid accidents than is required by the work alone. A workman with a low IQ is not accident prone in situations of simple hazards; but he is accident prone in other situations where the hazards are complex. These differences in hazard complexity probably account for the apparent inconsistency of studies on the relation of intelligence to accident rate.

Vision. Wirt and Leedke[24] found that 67 per cent of a group of paper-machine operators who did not meet a visual-requirement test had accidents serious enough to require medical attention the previous year, while only 37 per cent of those who did pass the test had such accidents.

Kuhn[25] found that in a survey of a large plant employing 15,000 people those who had lost time from accidents were inferior to the plant average on a number of visual performance tests. His data are shown in Table 9–8.

TABLE 9–8. COMPARISON OF THOSE WHO HAD LOST-TIME ACCIDENTS WITH PLANT AVERAGE ON VISUAL TESTS

Test	Plant average, per cent	Workmen having lost-time accidents, per cent
Acuity	20.2	23.1
Depth perception	14.0	17.3
Color discrimination	3.1	9.6
Muscle imbalance	16.0	19.2

Tiffin[26] found a similar relationship in a study of steel-mill employees. Visual tests identified certain accident-prone individuals (see Table 9–6 above). He also found that only 37 per cent of a group of paper-machine operators who passed visual tests had accidents during a given year, whereas 67 per cent of those who did not pass the vision tests had accidents. The same investigators found that there is an opposite relationship between accidents and deviations from the normal eye posture or balance (technically known as *phoria*). In near vision, those who had *divergence* deviations had a greater percentage of serious accidents. In distant vision, however, those who had *convergence* deviations had a greater number of accidents. These data are shown in Fig. 9–8. The measurement of these deviations in visual postural characteristics, or of phoria, is complicated and can be done only with a precision stereoscope.. Such devices are the Sight-screener and the Ortho-rater, in which the view cards are contained within the instruments. Still another is the Telebinocular, which does not vary greatly from the old stereoscope so popular in parlor entertainment a generation ago. All three instruments can be used for measuring visual acuity, phoria, depth perception, and color discrimination. By their use, a personnel department can identify those individuals who have inferior vision, and then send them to eye specialists for diagnosis and correction.

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[24] Wirt, S. E., and Leedke, H. N., Skillful Eyes Prevent Accidents, *Nat. Safety Coun. Industr. Nursing Sec., News Letter,* 1945, p. 10.

[25] Kuhn, H. S., An Appraisal of Visual Defects in Industry, *Trans. Amer. Acad. Ophthal. and Otol.,* June, 1941.

[26] Tiffin, *op. cit.,* p. 433.

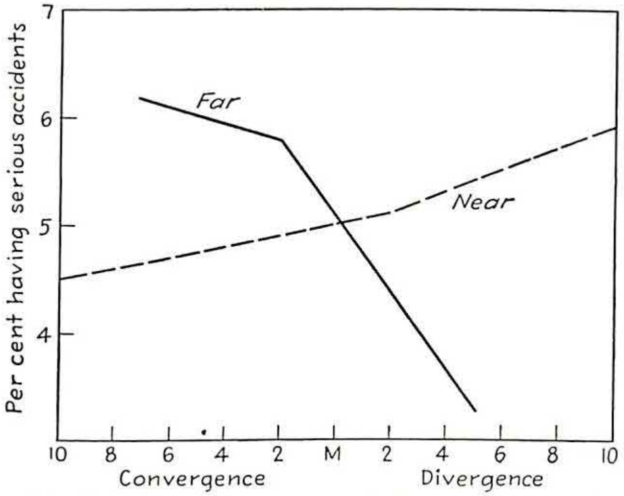

FIG. 9–8. Relation of far and near phoria to serious accidents.

Reaction Time. It has been found that reaction time (*i.e.*, the fraction of a second it takes an individual to perform an action) is significantly different between good and poor automobile drivers. Fletcher[27] found a statistically significant difference between good and poor drivers in braking reaction time, or the time it takes a driver to take his foot off the accelerator and place it on the brake. His data are shown in Table 9–9. The differences shown are so small, however, that a car driven by a poor driver would travel only a short distance further before stopping, even if the speed was in the higher brackets. The difference indicated in the simple breaking-time test would mean but 1.2-ft. distance if other factors were equal and the cars were traveling at a speed of 50 m.p.h. The car driven by the good driver would travel 27.6 ft. before the brakes could be applied, while the one driven by the poor driver would travel 28.8 before the brakes could be applied. If both cars were in equal mechanical condition, there would be but a 1.2-ft. difference in their stopping distances. It would seem that this could account for only rare accidents.

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[27] Fletcher, E. D., Preliminary Report on Special Tests, Part I, State of California, Department of Motor Vehicles.

TABLE 9–9. REACTION-TIME DIFFERENCES BETWEEN GOOD AND POOR AUTOMOBILE DRIVERS

Test	Good drivers	Poor drivers	Difference	Critical ratio
Braking time, sec.:				
Simple	0.377	0.393	.016	4.2
Vigilance	0.472	0.534	.062	9.0
Steering time, per cent:				
Simple	84.45	77.91	6.54	7.8
Vigilance	76.42	71.42	5.00	4.6

The National Safety Council[28] found that motor-coach operators who had fast reaction time had more accidents than those who were slower (see Table 9–12). Wechsler[29] found that both the fast reactors and the slow reactors among taxicab drivers had more accidents than those who were average in reaction time.

The value of reaction-time tests in spotting accident-prone individuals in industry has not been great. Farmer and Chambers[30] found that the correlation of reaction time with accident frequency was too low to be of value in accident prediction. This correlation among shipwrights was .20, among electrical fitters .07, and among engine fitters .16. Though the measurement of simple reaction time is one of the oldest techniques developed by psychologists, and is still one of the most accurate, it is apparently of but little value in predicting industrial accidents.

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[28] National Safety Council, Los Angeles Chapter, A Study of Psycho-physiological Selectivity of Employees, 1946.

[29] Wechsler, D., Tests for Taxicab Drivers, *J. Person. Res.*, 1926, 5, 24–30.

[30] *Op. cit.*

Perception-Dexterity Relationship. Drake[31] observed that workmen whose perceptual test scores were higher than their dexterity test scores were safer workmen than those whose perceptual test scores were lower than their dexterity test scores. In other words, accident proneness seems to be caused in part by low perception in comparison with dexterity. Figure 9–9 shows the test profile of a workman who was not accident prone. His dexterity was below average and his perception was above average. It also shows the test profile of a workman who was accident prone. His dexterity scores were higher than his perception scores. Perception exceeds dexterity in safe workmen.

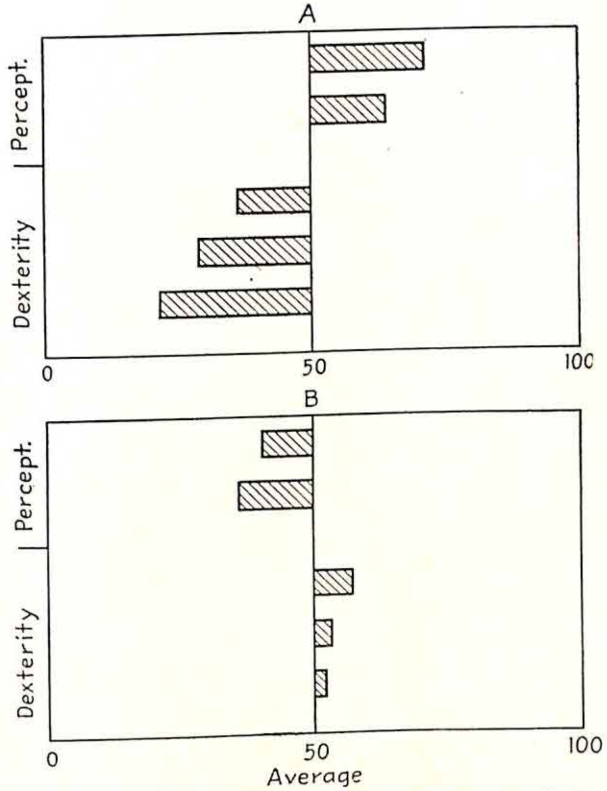

FIG. 9–9. Profiles of two workmen on dexterity and perceptual tests. *A* is a "safe" workman with a low accident rate; *B* is an accident-prone workman.

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[31] Drake, C. A., *Personnel Selection by Standard Job Tests,* Chap. 12, McGraw-Hill Book Company, Inc., New York, 1942.

Drake believes that the frequency and severity of accidents, as well as the experience of the workman, should be considered in measuring accident proneness. He devised an accident index formula which takes all these factors into consideration. It is as follows:

$$\text{Accident index} = \frac{\text{number of accidents} \times \text{severity}}{\text{length of service in months}}$$

Accident severity is scaled from 1 to 10, depending on the time lost and the resulting degree of impairment in working ability.

When workmen are rated by the accident index and by difference scores on perception and dexterity tests, there is a relationship as illustrated in Table 9–10. The difference scores are determined by subtracting the dexterity scores from the perception scores. Those workmen whose perception was definitely superior to their dexterity had an accident index of only 4.29, while those whose dexterity was greater than their perception had an accident index of 18.47.

TABLE 9–10. QUARTILE DIFFERENCE SCORES ON PERCEPTION AND DEXTERITY TESTS AND ACCIDENT INDEX

Quartile	Difference scores (perception minus dexterity)	Accident index
I	+18 to +60	4.29
II	− 5 to +15	3.42
III	−12 to − 6	6.57
IV	−48 to −15	18.47

Perception was measured by simple sorting tests requiring inspection and classification, not unlike the old card-sorting test. Dexterity was measured by tests comparable to the well-known peg boards. Drake believes that if men are selected on the basis of this difference in perception and dexterity scores, accidents can be reduced at least 50 per cent. In fact, when 18 new employees were selected on this basis, the accident index for the group was 70 per cent below the plant average. It appears that those workmen who tend to act more quickly than they perceive also tend to have more accidents.

Test Batteries. Ghiselli and his associates[32] gave a battery of tests to a group of 153 streetcar motormen in San Francisco. Workmen making high scores generally had fewer accidents than those making low scores. The data are shown in Table 9–11. The percentage differences indicate that foot reaction time, tapping, dotting (speed tests), knowledge of mechanical principles, and distance judgment all have value in discriminating between those who have above- and below-accident frequency.

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[32] The use of test scores for the prevention of accidents of streetcar motormen reported in Ghiselli, E. E., and Brown, C. W., *Personnel and Industrial Psychology*, p. 387, McGraw-Hill Book Company, Inc., New York, 1948.

TABLE 9–11. RELATION OF TEST SCORES TO ACCIDENT FREQUENCY

Test	Per cent below average accident frequency		
	Workmen with above average scores	Workmen with below average scores	Difference
Pencil and paper:			
Tapping	63	38	25
Dotting	56	41	15
Mechanical principles	55	44	11
Judgment of distance by perspective	56	44	12
Visual:			
Acuity	51	49	2
Field of vision	51	48	3
Glare recovery	48	49	−1
Distance judgment	55	45	10
Performance:			
Foot reaction time	58	42	16
Steadiness	50	50	00

The National Safety Council[33] administered a battery of tests to 180 motor-coach operators. The "passing" score was the average score made by those operators who had had less than the average number of accidents. The relation of accident frequency to four of the tests used is shown in Table 9–12. Vision tests showed no relation to accident frequency.

Farmer and Chambers[34] gave a battery of tests, which they called "aesthetokinetic," consisting of dotting, two-hand coordination, pursuit meter, etc. They found that the accident rates for three groups of workers were lower for those who scored higher on the tests. By eliminating all those who scored below average on the tests, they could reduce the accident rate by one-third. The results are shown in Table 9–13.

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[33] National Safety Council, *op. cit.*

[34] Farmer, E., and Chambers, E. G., Tests for Accident Proneness, *Industr. Hlth. Res. Bd. Rept.*, No. 68, London, 1933.

TABLE 9–12. RELATION OF ACCIDENT FREQUENCY TO TEST SCORES OF 180 MOTOR-COACH OPERATORS
(In per cent "passing" test)

Test	Accident frequency—9 months					
	0–1	2–3	4–7	8–9	10–12	13–17
Simple reaction time	57	70	72	86	86	89
Muscular reaction	100	90	83	76	91	66
Depth perception	86	80	87	76	82	89
Bodily stability	71	90	65	48	55	45

TABLE 9–13. PER CENT OF AVERAGE ACCIDENT RATE MADE BY GROUPS SELECTED BY AESTHETOKINETIC TESTS

Accident rate	Shipwrights	Electric fitters	Engine fitters
Of whole group	100	100	100
With lowest ¼ on tests excluded	80	88	90
With lowest ½ on tests excluded	61	60	74

Obviously, more research is needed to determine just what measurable psychological traits are correlated with accident proneness. Like job success, accident proneness is closely associated with the peculiar nature of the job situation, and tests that are useful in one situation are of no predictive value in others. The characteristics of accident proneness and their prediction in each job situation must be studied by careful methods before a useful program of accident prevention can be adopted.

ACCIDENT PREVENTION

It is obvious from the data presented above that the accident rate of any company can be cut down when workmen are carefully selected by the use of tests that have first been validated with accident rate as the criterion. Workmen who are less accident prone at the time of employment will, other things being equal, have fewer accidents than those who are more accident prone. The determination of appropriate tests, however, can be done only by appropriate research.

Even with the most careful selective procedures, accidents continue to occur. They are not all due to accident proneness. The least accident-prone workmen sometimes have accidents. Accident prevention also necessitates the attention of experts in safety procedures.

The first step in accident prevention is the organization of the safety department or of the needed safety function. Safety is important enough to merit a separate department, but in small establishments it is often assigned to the personnel, or maintenance, or production departments. Too often a specialist in safety is not employed and it becomes the additional responsibility of some already overworked department head. Safety is too important from a dollars and cents point of view to be relegated to a minor status. Safety practice is too much of a field of specialization to be performed by someone who is not properly trained for it.

In 1943, the War Department published a "Minimum Safety Program" for the "guidance of private and government-operated industrial establishments engaged in the manufacture, handling, or storage of war materials." This program is of sufficient value to merit reporting in some detail. It is as follows:

Personnel

One full-time safety director in establishments having a total of 1,500 or more industrial employees (including all shifts).

One part-time safety director in establishments having less than 1,500 such employees.

Two full-time assistants to the safety director in establishments having a total of 10,000 or more industrial employees (including all shifts).

One full-time assistant to the safety director in establishments having over 5,000 and less than 10,000 such employees.

Duties

Plan and direct all safety activities, work with the central safety committee, devise corrective measures to prevent accidents, and see that such measures are made effective.

Hold personal interviews with foremen and supervisors concerning specific matters of hazards and responsibility for their correction.

Make personal inspections of the plant and investigate fatal and unusually serious accidents.

Maintain necessary records and statistics relating to accidents, injuries, inspections, and safety department activities.

See that safety recommendations are properly attended to.

Direct a check of specifications for new machines, processes, and equipment, for compliance with existing codes, laws, and safety requirements, and have all equipment fully inspected before it is placed in use.

Inspections

Safety inspectors should have knowledge of safety standards and practices in relation to the production methods and operations of the establishment.

There should be one full-time inspector for each 1,500 industrial employees.

Inspections should be made of structures, tools, equipment, materials, work performance, and safety appliances and equipment.

Recommendations should be made regarding unsafe mechanical or physical conditions and unsafe practices of employees.

Specific items for inspection include: employee safety practices; housekeeping, aisle and work spaces; guarding of transmission and machine equipment; elevators, cranes, and other hoisting equipment; exits, floors, stairs, and structural conditions; light, ventilation, and sanitation; personal protection equipment; ladders, portable steps, boilers and other pressure equipment.

Safety is an integral part of production efficiency. The safety director should report directly to the production superintendent and from him derive the necessary authority to have unsafe practices and unsafe conditions corrected. If the safety director is also trained in production methods (he is then called a safety engineer) he can be of value in improving methods as he eliminates hazards. His objective, as well as that of the employees under him in an establishment, is to secure the greatest amount of production of standard quality at the least over-all cost. By reducing accidents, he makes a major contribution to the attainment of this goal.

SAFETY EDUCATION

The National Safety Council reports that both accident frequency and accident severity have been greatly reduced in recent years. The 1947 frequency rate was 58 per cent under that of 1930, while the accident severity rate of 1947 was 50 per cent under that of 1930. The General Electric Company has reduced the accident frequency rate from 45.2 in 1917 to 6.5 in 1946. This is a reduction of 85 per cent. The data for these and intervening years are shown in Fig. 9–10. These records have been due in large part to teaching workmen *not* to perform unsafe acts. Properly conducted safety training programs can be very effective. The effect of one training program on accident frequency is illustrated in Fig. 9–11. A series of four foremen's meetings was held on safety problems. The average accident frequency per month for the 11 months following the first meeting was 23. Then a second meeting was held. The average accident frequency for the next 12 months dropped to 14. After the third meeting, the accident frequency took another drop, to 9. After

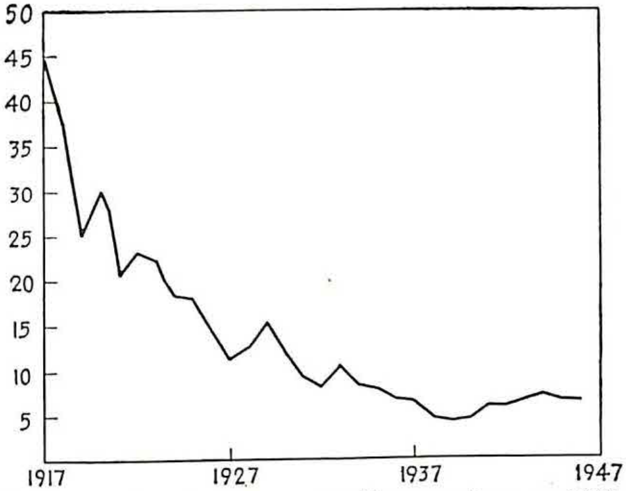

FIG. 9–10. General Electric Company accident rate for years 1917 to 1946.

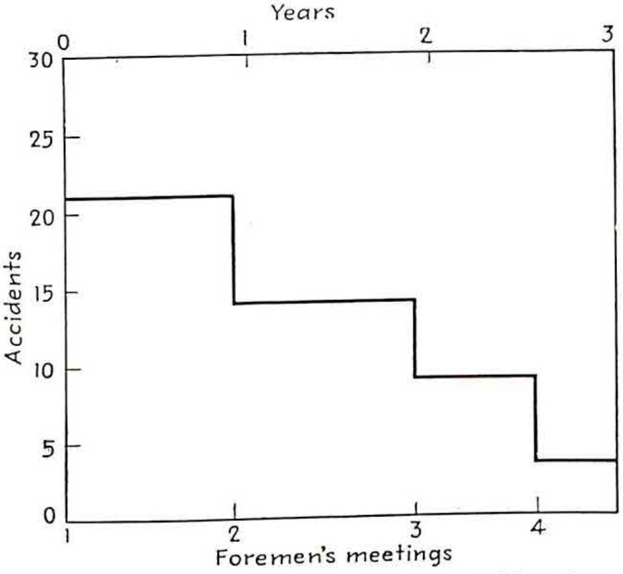

FIG. 9–11. The effect of foremen's meetings on accident frequency.

the fourth and last meeting, the average accident frequency dropped to 3.5 per month.

Training Foremen. The key man in any safety program is the foreman or supervisor. Safety campaigns and safety inspections cannot take the place of the constant alertness of the foreman for the performance of unsafe acts and the existence of unsafe conditions. He is the only man who can successfully execute a safety program. Safety rules and regulations are of no value if the foreman does not see that they are constantly observed. Consequently, the first step in safety education is the training of foremen.

Foremanship training in safety is usually conducted by the director of safety. While his authority should be great enough to enable him to put across a safety program regardless of apathy and opposition, he should *sell* the program and secure cooperation in its installation. Foremen should understand that a good safety program will help in producing more material of standard quality at lower cost.

Perhaps the best way to get across the nature of a course in safety education for foremen is to outline the content of a series of class meetings. It should be said at the outset that the academic lecture as such is seldom used in any sort of industrial training. It is not enough to throw a bunch of ideas at a group of foremen. The important thing is not what the instructor does but what the foremen learn. The JIT warning is again appropriate: "If the student doesn't learn, the instructor hasn't taught." Consequently, the meetings on safety for foremen are conferences led by the safety director. He presents ideas all right, but he presents them in answer to questions. He may even lecture very briefly to present a part of the safety program, but this is followed by discussion of problems concerning its application in specific departments. Furthermore, a good discussion leader does not answer all questions directly. If possible, he gets the foremen to answer their own questions. He leads the discussion, makes suggestions when necessary, presents facts when they are applicable, asks questions that may have been overlooked, explains to avoid misinterpretations, takes over when arguments develop, stimulates discussion on reasons for even hidden opposition, and does it all with an attitude of cooperation and mutual respect. Good safety engineers are not always good conference leaders. They may not be good even in cooperation; yet on these factors—conference leadership and cooperation—the success of any safety program depends.

First Meeting

Objective—To understand the function of the safety department and its relationship to other departments.

Unsafe acts and unsafe conditions produce accidents, although injuries may or may not occur. Accidents of all kinds cost money: in delayed production, damaged equipment and materials, human injuries, interruptions and distractions of neighboring workmen, etc. The safety department recognizes these acts and conditions, plans for their elimination, and submits these plans to department heads for approval. Department heads remain "bosses" of their departments but as such are responsible for the elimination of unsafe acts and unsafe conditions. The safety engineer is a specialist who advises foremen on ways and means of operating without accidents.

Second Meeting

Objective—To understand the nature of accidents.

Accidents are atypical or unscheduled acts and events which may occur in the production process. Heinrich, in his *Industrial Accident Prevention* (McGraw-Hill Book Co., Inc., 1941) outlines five factors in the accident sequence:

1. Ancestry and social environment.
2. Fault of the person.
3. Unsafe acts and/or unsafe conditions.
4. The accident.
5. Injuries.

There are approximately 30 no-injury accidents to each injury accident, and 29 minor-injury accidents to each major-injury accident. Any accident may cause an injury.

Third Meeting

Objective—To understand what unsafe acts are and why workmen perform them.

Unsafe acts usually begin as "short-cut" procedures which are performed with unusual care and do not result immediately in accidents. The American Standards Association lists these as follows:

1. Operating without authority.
2. Operating or working at unsafe speed.
3. Making safety devices unoperative.
4. Using unsafe equipment, hands instead of equipment, or equipment unsafely.
5. Unsafe loading, placing, mixing, or combining.
6. Taking unsafe position or posture.
7. Working on moving or dangerous equipment.
8. Distracting, teasing, abusing, or startling.
9. Failure to use safety attire or personal protective devices.

Though no accident has yet occurred, if there is a chance of accident in a procedure it is then unsafe.

Fourth Meeting

Objective—To recognize unsafe conditions and learn how to eliminate them.

The American Standards Association lists unsafe conditions as follows:

1. Inadequately guarded equipment—improper height, strength, mesh, etc.
2. Unguarded equipment.
3. Defective condition (rough, sharp, slippery, decayed, corroded, frayed, cracked, etc.).
4. Unsafely designed machines, tools, etc.
5. Hazardous arrangement or process (poor housekeeping, congestion, blocked exits, blind traffic corners, etc.).
6. Unsafe illumination, glare, shadows, etc.
7. Inadequate ventilation.
8. Unsafe dress or apparel (goggles, masks, loose clothing, safety shoes, etc.).

Specific conditions in the local plant and in each department are discussed.

Fifth Meeting

Objective—To learn how to study and report accidents.

In addition to identification data (department, employee's name, time, etc.), cost in hours lost, material spoiled, tools and machinery damaged, each accident report should contain information about the following:

1. Agency involved—place, tool, machine, material, etc.
2. Act performed—walking, lifting, operating, adjusting, etc.
3. Accident—exactly what happened.
4. Injury, if any.
5. What unsafe act was performed, if any.
6. What unsafe condition exists, if any.
7. What corrective action should be taken.

Specimen accident reports are analyzed and discussed.

Sixth Meeting

Objective—To understand the function of supervisors in a safety program.

Supervision means just that. It is more than merely holding an office and exercising the authority that goes with it. It is more than being available for consultation. Supervision is passing up and down the line to see that work is being performed in the prescribed ways. Are materials located where they should be? Are tools in proper condition and location? Are machines properly oiled and operating smoothly? Are workmen making the proper movements in processing materials? Are they wearing proper clothing? Supervision is hard work. If the supervisor's time is taken up with other things, supervision should then be delegated to someone else who can spend his time supervising. Men cannot be trusted to work without supervision. It is the function of the foreman to see that his department is properly supervised.

The above outline is very sketchy and perhaps inadequately illustrates the content of a 12-hour course. However, it is intended to be only the core of discussions applied to a local situation. Safety education is not something to be gotten across to a group of foremen, but rather something to be evolved by cooperative action of the foremen under leadership.

Training Workmen. Safety education for the working man is not essentially different from job training. If a job process is properly designed and the workman performs it according to that design, there will be no accidents on the job—except perhaps a rare one due to machinery failure. Proper job performance, then, is the best way to avoid those accidents associated with job performance. Figures 9–2 and 9–3 and Table 9–4 all indicate that experienced workmen do not have as many accidents as men with less experience.

All industrial establishments have safety rules and regulations which must be learned by every workman, however. These rules range from brief statements that may appear on bulletin boards to more elaborate statements which may be printed in booklet form. They concern wearing apparel, safety belts, eye protection, machinery handling, lifting, danger zones, fires and explosions, first-aid stations, crane and truck signals, etc. Many companies require new workmen to sign statements that they have been instructed concerning the safety rules, and some even give an examination to check on the degree of safety information absorbed. In addition to written safety rules, there are in every company certain safety practices and notices of certain danger areas which are passed on to the new workmen by word of mouth. This information is part of each new workman's indoctrination and orientation. He often gets it when the written safety rules are explained to him.

Information about safety rules, however, is not the crucial factor in safety education. As in other respects, a man who knows many facts is not always well-educated. The educated man *uses* his information. He not only knows facts, but he acts on the basis of them. It is not the knowledge of safety rules but the practice of them that is important in preventing accidents. Men must not only know what safe acts are, but they must also perform safe acts. Safety habits are as much the goal of safety education as safety information.

The formation of safety habits is essentially the same as the formation of any other habits. The laws or conditions for habit formation are here operative. Safety habits are more easily formed when

1. *Motivation is strong.* The workman should want to form the habit. Safety contests are positive motives and drastic penalties are negative ones. Rewards for long safety records are often effective motives.
2. *Exceptions or violations do not occur.* If a safety habit is violated (the workman "takes a chance"), it makes the next violation easier. Soon the violation itself becomes a habit. Violation of safety rules should not be allowed whether or not accidents result from it. Inspectors should be constantly on the job.
3. *The habits are useful.* Safety rules must be kept up to date. Rules that are no longer appropriate for changed situations are difficult to enforce. A rule to wear goggles when grinding is not useful after a grinding machine has been properly masked. Safety rules must be useful and the workman must understand why they are useful.
4. *Short cuts are made safe.* It is often easier and more economical to make a short cut safe than it is to enforce a longer but safer procedure. It is safer but more difficult to operate a hot saw at a given distance, but screen guards will make close operation just as safe. Or, a well-guarded passageway through a dangerous area is better than a long route around the area. Jobs and plant operations should be designed in the most economical manner and then made safe.

Safety education takes place in various plants in a variety of ways, some direct and some very indirect. The success of the various methods seems to depend on local conditions and the personalities who administer them. Some of the more commonly used procedures are listed by Heinrich[35] as follows:

1. Placing responsibility on foremen for the investigation of accidents and for correcting unsafe practices and mechanical hazards.
2. Safety meetings, especially conference-type meetings.
3. Publicity—safety bulletins, posters, notices, special letters, payroll envelope inserts, slides and films, house organs, etc.
4. Safety plays.
5. Instruction in first aid and resuscitation.
6. Employee rule books.
7. Hiring and training programs.
8. Use of local employees in setting a good example.
9. Safety messages on work orders, correspondence, etc.

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[35] Heinrich, H. W., *Industrial Accident Prevention*, p. 361, McGraw-Hill Book Company, Inc., New York, 1941.

10. Contests,
11. Job-safety analysis.
12. Featuring specific safety-practice rules.
13. Attendance at safety conferences.
14. Preparation of safety codes.

Safety Campaigns. The best way to establish and maintain a good safety record is for all supervisors to be constantly alert for any safety-rule violation. Violators should be punished whether or not an accident occurs. Good safety records are not established by occasional safety campaigns. Safety must be an integral part of plant operation. The safe way should be the only way tolerated. Men who refuse to operate in that manner should be separated from the company.

Posters concerning safety, mass safety meetings, pay-envelope inserts regarding safety, safety bonuses, etc., are not harmful if they are supplemental to regular and frequent safety inspections and inevitable retribution for the performance of unsafe acts. Too frequently safety campaigns are substituted for constant attention to the safety factor. A safety program may well be initiated by some sort of a safety campaign, but after it is established and properly operating, the periodic campaign is not necessary. Supervision is then as alert to safety as it is to other factors in efficiency.

When accidents do occur, their occurrence and the unsafe act or condition causing them should be publicized. The importane of safety and the justification of safety rules can thus be emphasized. A former student of the author, now safety director for a large corporation, relates that on observing a workman perform an unsafe act he said to him: "Would you mind giving John Doe a message for me?" The workman, remembering that John Doe had been killed a few weeks before this, said: "That will be difficult. John Doe is now under 6 feet of sod." "Oh no," said the safety inspector. "You will see John Doe sooner than you think. John was killed because he violated a safety rule. You just violated another safety rule. You won't be far behind John. I will speak to your foreman immediately about a man to replace you." Such constant campaigns for safety are far superior to the periodic flash of safety posters which alone have little effect on safety records.

SAFE WORKING CONDITIONS

State laws and state safety inspections take care of the more flagrant unsafe conditions in most industries. Even so, in most plants where there is no safety engineer a brief inspection will reveal all sorts of unsafe conditions. The following were recently noted by the author as he passed through a wire and nail plant:

1. Main entrance from office building to plant is down railroad track. No sidewalk.
2. Housekeeping bad. Materials of all kinds blocking passageways. Places slippery from both water and grease.
3. Belts and pulleys from overhead power unguarded. In one place, it is necessary to stoop to pass under an unguarded shaft.
4. Windows dirty and artificial lighting poor. Machine was being repaired in dim light, perhaps less than 2 ft.-c.
5. Plant trucks operated at unsafe speed—evidently without governors.
6. Passage from nail shop to wire shop is across railroad track. Used by both pedestrians and plant trucks. No guards or signals.
7. Operator at a burr press could sit but no stool is provided. Unnecessary fatigue.
8. Overhead monorail passes over two punch-press operators. No guards.

Accident prevention depends on the elimination of unsafe conditions as well as unsafe acts. It is difficult to motivate men to observe safety rules when the company violates them. The first step in a safety program is to put the plant in a safe condition.

Housekeeping. Poor housekeeping around an industrial plant is not the result of unsafe acts per se, but it certainly results in unsafe conditions. It is an obligation of a company to provide adequate storage space for unused materials and machinery, receptacles for waste materials, janitor personnel to keep the place clean, racks for temporary storage of tools and equipment, waste and brushes for keeping machinery clean, paint for dirty-looking spaces (which can also improve lighting conditions), bins and cans for unprocessed and processed materials, etc. With all the possible needs for good housekeeping supplied, it is then the direct responsibility of the foreman to see that good housekeeping results.

It is unnecessary here to review the accident hazards created by poor housekeeping. Falls, which constitute approximately one-fifth of all industrial accidents, are to a great extent caused by various factors of poor housekeeping. Gimbel[36] lists the following "typical accidents due to poor housekeeping":

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[36] Gimbel, M. A., in *Industrial Safety*, R. P. Blake (ed.), Chap. 12, Prentice-Hall Inc., New York, 1943.

1. Tripping over loose objects on floors, stairs, and platforms.
2. Articles dripped from above.
3. Slipping on greasy, wet, or dirty floors.
4. Running against projecting, poorly piled, or misplaced materials.
5. Tearing hands or other parts of the body on projecting nails, hooks, or sticks.

To these may be added the danger of fire. Oil-soaked rags and discarded clothing may ignite from spontaneous combustion. Dirt and dust often ignite from sparks. Once a fire is started, it spreads more rapidly in a plant where there is poor housekeeping.

Machine Guarding. In any manufacturing industry, one of every four injuries is due to "mechanical causes." It is especially important that guards be placed around all forms of transmission machinery—gears, shafts, pulleys, etc. The American Standards Association (29 W. 39th St., New York) has developed a safety code for guarding transmission machinery called "Safety Code for Mechanical Power Transmission Apparatus." This code should be observed closely, especially in those states which do not require it by law and insure it by state safety inspections.

A machine guard must be carefully designed and, if possible, built into the machine. Modern machines are often built with safety guards as an integral part of their design and construction. Older machines must have guards attached to them. The primary purpose is, of course, to prevent contact with a point of danger. A secondary purpose is to design a guard in such a way that it does not interfere with the operation of the machine. A third purpose is to design it so that it can be removed easily for machine repair. If possible, guards should not be placed so that they interfere with oiling and servicing the machine. Oil cups with long tubes often can be placed outside a guard to take care of a difficult location. Sometimes it is necessary to place access panels in guards to permit oiling. However arranged (and each machine constitutes a peculiar problem), at all times when the machine is in operation the guard must prevent human contact with points of danger.

Machinery guarding is so much a field of specialization that it is doubtful if a maintenance department is always competent to design and install guards on dangerous machinery. The adequacy of guards installed even by experts should be checked by reference to a good code for guarding power-transmission equipment. The National Conservation Bureau (60 John St., New York) publishes a *Handbook of Industrial Safety Standards* which is of value in such checking.

Lighting. Lighting, briefly mentioned before in this chapter, will be fully discussed in Chap. 11. It is mentioned here now to emphasize its importance as a factor in accident prevention. Poor lighting constitutes an unsafe condition which causes many accidents.

Maintenance. Prompt and efficient maintenance is vital to both production and safety. In too many industries, the maintenance department is understaffed and poorly qualified. There is a lag between requisitions for repairs and their execution. The author knows of one instance where a roof exhaust fan broke and was not repaired for 5 weeks after it was reported to the maintenance department. The concentration of smoke, dust and gases was so great that hazards to health and safety were increased. The maintenance department was overworked and far behind in servicing the demands made of it. This plant was full of examples of makeshift repairs made by workmen themselves because the maintenance department was so slow in functioning after a need was reported. Defective steps, ladders, cables, electric cords, machinery controls, safety guards—all maintenance repairs should be repaired by the maintenance department. In fact, the correction of *all* unsafe conditions reported by the safety inspector must be made by the maintenance department.

The work of maintenance is as varied as that of industry itself. There must be electricians, from semi-skilled up to the engineering level. There must be plumbers, mechanics, toolmakers, blacksmiths, masons, carpenters, painters, sheet-metal workers, and a host of other specialists. In small establishments, a few men must be able to perform all these functions. Maintenance is too often underrated both in importance to the company and in the difficulty of the work performed. A plant can be no more efficient than its maintenance department. Certainly the success of a safety department depends on the cooperation and efficiency of the maintenance department.

SUMMARY

Accidents occur with much greater frequency in American industry than is necessary. Many could be prevented by the employment of well-trained safety engineers with authority to place accident-prone workmen on jobs with low hazards and to replan jobs so as to eliminate unnecessary hazards. Those companies that have made safety a primary objective have reduced their accident frequency and severity to small fractions of the original rates (see Fig. 9–10). Safety control by specialists pays off in large dividends.

RECOMMENDED READINGS

Blake, R. P., *et. al.: Industrial Safety,* Prentice-Hall, Inc., New York, 1943.

DeSilva, H. R.: *Why We Have Automobile Accidents,* John Wiley & Sons, Inc., New York, 1942.

Dickie, A. L.: *Production with Safety,* McGraw-Hill Book Company, Inc., New York, 1941.

Ghiselli, E. E., and Brown, C .W.: *Personnel and Industrial Psychology,* Chap. 14, McGraw-Hill Book Company, Inc., New York, 1948.

Harrell, T. W.: *Industrial Psychology,* Chap. 10, Rinehart & Company, Inc., New York, 1949.

Heinrich, H. W.: *Industrial Accident Prevention,* McGraw-Hill Book Company, Inc., New York, 1941.

Lippert, F. G.: *Accident Prevention Administration,* McGraw-Hill Book Company, Inc., New York, 1947.

National Safety Council: *Accident Facts,* Chicago, annual.

Ryan, T. A.: *Work and Effort,* Chap. 12, The Ronald Press Company, New York, 1947.

Tiffin, J.: *Industrial Psychology,* Chap. 13, Prentice-Hall, Inc., New York, 1947.

Vernon, H. M.: *Accidents and Their Prevention,* Cambridge University Press, London, 1936.

Chapter 10

MONOTONY AND BOREDOM

- Characteristics of Boring Work
  - Short-cycle Repetitive Work
  - Easy Work
- Characteristics of Bored People
  - Maladjusted Temperament
  - Maladjusted Aptitudes
  - Other Maladjustments
  - Lack of Interest
  - Inability to Daydream
- Remedies for Boredom
  - "Round Pegs in Round Holes."
  - Alternating Work
  - Rest
  - Music

Monotony and *boredom* are terms here used interchangeably to designate feelings of tiredness, effort, lack of interest, unpleasantness and futility. The activity being performed at the time is usually blamed for these feelings. The individual would rather quit and do something else—except for some strong remote goal achieved by continuing the behavior. This remote goal is usually a pay check, or hope of promotion, or fear of social disapproval, or just a habit of sticking to disagreeable work. There are two characteristics, then, of monotonous or boring behavior: the desire to quit an activity to avoid unpleasant experiences, and the desire to continue it to accomplish some resulting pleasant condition. There is a conflict within the individual. He wants to avoid the boring behavior and he wants the results achieved by continuing the boring behavior.[1]

Boredom is expressed in various ways. One workman becomes careless and accident prone; another stays at home to avoid performing the boring work; another becomes a trouble-maker and lowers the morale of those with whom he comes in contact; another turns out inferior products; another quits the job entirely. Whatever the workman does as a result of his feeling of boredom, he is a less efficient workman than he would be if he did not feel that conflicting desire to quit his job and also to continue it. Boredom costs American industry millions of dollars per year, much of which is avoidable.

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[1] The author sees no value in the labored distinction sometimes made between the two terms "boredom" and "monotony." "The work is monotonous so the workman becomes bored." Whether or not boredom refers only to the feelings of a workman toward his work, and monotony only to characteristics of the work itself—the significant fact is that a worker wants to quit the work he is doing for more immediate pleasure, yet he also wants to continue it for more remote pleasure. It is a conflict situation which the workman himself designates by both terms—boring and monotonous.

The extent of boredom is unknown. The English industrial psychologist Wyatt[2] and one of his associates reported a survey of women employees which showed that 3 per cent were seldom bored, 33 per cent were occasionally bored, 38 per cent were frequently bored, 23 per cent were severely bored, and 3 per cent were almost continually bored. The writer attempted a similar survey in a Southern textile mill but found that the definitions of boredom and its degrees were so ambiguous that workmen did not report comparable degrees of boredom in the same way. The study did reveal to the mill management, however, that boredom was much greater than they had realized.

This chapter will discuss the characteristics of work which cause some workmen to feel bored, the characteristics of workmen who are prone to feeling bored, and the various attempts to remedy boredom. Some work is more boring to some workmen than other work; some workmen are more easily bored than other workmen; and some conditions make a boring situation (whether due to the workman himself or to the work he performs) less boring.

CHARACTERISTICS OF BORING WORK

It is difficult to generalize about monotonous work because of individual differences between workmen. All workmen are not bored by the same work. Few jobs are boring to all workmen and few jobs are not boring to some workmen. However, some work is boring to so many workmen that it is properly designated as monotonous.

Short-cycle Repetitive Work

Few workmen enjoy short-cycle repetitive work. There is too much sameness, too little challenge to human effort except speed, too much activity for a few muscles and too little for others. In other words, not enough of the "whole man" is being used.

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[2] Wyatt, S., and Langdon, J. N., Fatigue and Boredom in Repetitive Work, *Industr. Hlth. Res. Bd. Rept.*, No. 77, London, 1937.

How short a work cycle must be to become monotonous depends on the type of work, the type of workman, the conditions of work, and so many other factors that a specific study of each situation is imperative. The proper balance between the efficiency of a work cycle and its monotony is not the same for all work operations. However, in most cases the monotony of short-cycle repetitive work depends on three factors: the length of time during which the repetitive activity is performed, the nature of the repetitive activity, and the nature of the relief or alternative activity performed instead of the repetitive work.

Wyatt and his associates[3] studied the effects on production of the frequency and duration of alternating two short-cycle repetitive operations in making cigarettes by hand. The operations consisted of putting the tobacco in the paper, called "making," and trimming the ends of the cigarettes, called "trimming." Table 10–1 shows the amount of production when the two operations are alternated for various periods of time. The data are in per cent of production when "working all day" is taken as the base. Note that alternating the two operations is always better than performing a single operation all day.

TABLE 10–1. RELATION OF PRODUCTION TO ALTERNATING TWO ACTIVITIES IN MAKING CIGARETTES

Activity	Relative Production
Making—all day	100
Making and cutting:	
Alternate 1 hour	112
Alternate 1½ hours	113
Alternate 3 hours	106
Alternate according to choice of worker	107

The second factor affecting the monotony of short-cycle repetitive work is the nature of the work itself. Wyatt studied this factor in an ammunition plant. There were three operations in assembling cartridge cases—stacking, assembling, and pushing down wads. Items for each operation were placed on trays. The length of each operation could be controlled by regulating the number of items on each tray. It was found that the stacking operation was more proficient if the work periods without change were relatively long. On the other hand, both assembling and pushing down wads were more speedily performed when activity was changed with moderate frequency. These results are shown in Table 10–2.

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[3] Wyatt, S., Fraser, J. A., and Stock, F. G. H., The Comparative Effects of Variety and Uniformity in Work, *Industr. Fat. Res. Bd. Rept.*, No. 52, London, 1928.

TABLE 10–2. RELATION OF PRODUCTION ON THREE OPERATIONS TO FREQUENCY OF CHANGE FROM ONE OPERATION TO ANOTHER

Items on each tray	Stacking	Assembling	Pushing down wads
750 (frequent changes)	100	100	100
1,000	109	108	106
1,250	113	107	102
1,500 (infrequent changes)	115	93	96

Third, the monotony of short-cycle work is affected by the nature of the alternative activity performed as "relief" from the repetitive operation. The relief operation must be sufficiently different from the work already being performed to reduce the state of boredom. Wyatt found that soap-wrapping proficiency was decreased 3.2 per cent, handkerchief folding was increased 1 per cent, and bicycle-chain assembling was increased 3.6 per cent when varied operations were introduced to relieve the monotony of the usual procedures (see Table 10–3). None of the differences were great but they did indicate that the monotony of work is relieved only if the alternative work is sufficiently different from the work already being performed to revive interest and feeling of euphoria. This is discussed in more detail later in this chapter.

TABLE 10–3. AVERAGE PRODUCTION PER HOUR FOR UNIFORM AND VARIED PRODUCTION PROCESSES

	Soap wrapping	Handkerchief folding	Bicycle-chain assembly
Uniform process	227.9	25.6	65.7
Varied process	220.6	25.9	68.1
Gain or loss	−7.3	0.3	2.4
Per cent gain or loss	−3.2	1.1	3.6

EASY WORK

When work is adequately difficult for the workman he has little time to feel bored. His attention is taken up with the performance of his duties. Even if he is not greatly interested in his work he is too busy to be bored. His lack of interest may be manifest when he is off the job but he has little time to be uninterested or bored when he is at work. Of course, he may stay at home the next day to avoid the work entirely but while at work his energy and attention are devoted to performing tasks that are almost but not quite too difficult for him. His work challenges his entire efforts.

Easy work, on the other hand, may occupy the hands, but the mind is free. Mental effort is then not required. The workman can perform his duties automatically and he has time to think—lots of time. Some workmen can adapt to this situation. They can daydream, either about practical problems or fantastic experiences. Some workmen really enjoy themselves while performing work that does not require much attention. They may be characterized as mentally lazy, but at any rate they are not bored while performing easy work. Other workmen cannot easily divorce what they do with their hands from what they do in their minds. They have not learned to daydream while their hands are busy with highly habitualized work. As soon as their hands can perform tasks without mental direction, their minds are idle. They become bored. Time passes slowly. They feel tired. The work is uninteresting and futile.

The ideal remedy for boredom caused by work that is too easy is proper job placement. Easy work should be performed by workmen who have such low mental capacity that the work is not easy, or by workmen who can engage in and enjoy mental experiences while at work, even though these have no connection with the work being performed. Workmen who are bored while performing easy work should either be placed on more difficult jobs or not employed at all. A bored workman on an easy job will become a troublemaker, or turn out inferior work, or become a safety liability, or quit. Whatever he does will cost the company money.

With the rapid increase in work mechanization and simplification, the increase in easy jobs has been and will continue to be great. There is more and more demand for workmen of low mental ability to perform the low, semiskilled jobs being constantly created by work simplification. The situation exists in some industries more than in others, but in all industries it becomes increasingly necessary to relieve boredom, to entertain the unoccupied mind, to introduce variety in the easy work being performed.

CHARACTERISTICS OF BORED PEOPLE

It should be emphasized again that boredom or monotony is not necessarily a job characteristic for all workmen. Short-cycle work and easy work are not boring for workmen who like repetitive and easy work. On the other hand, complex and difficult work is very boring for workmen who do not like work that requires great effort. They are bored with variety and difficulty. Boredom is a human trait that may or may not be brought out by a work experience.

In a certain industry, four girls were engaged in spreading small mica flakes over a slowly moving fiber belt. Labor turnover on this job had been great. Interviews revealed that one girl had just "hated" the work, two others were waiting to be transferred to "more interesting" work, while the fourth "loved every minute of the day." Subsequent effort finally got three other girls like the fourth one, and the labor turnover problem was solved. The job was not boring; rather some girls were bored with it.

It is doubtful if there is any human being who is bored by all work, and it is likewise doubtful if there is any human being who cannot be bored by some work. In other words, everyone is bored by work of some sort but no one work will bore everyone. Regardless of the nature of work, some workman somewhere will enjoy its performance. The problem is to put each man on the job that does not bore him.

People who are easily bored have certain characteristics which have been identified and described. These characteristics can be discovered, and the degree of boredom proneness which predisposes workmen to boredom can be predicted.

MALADJUSTED TEMPERAMENT

Many years ago psychologists recognized that an individual's success in life depended, in part, on his ability to perform the tasks of his job and, in part, on his ability to handle the difficulties of his job calmly and with freedom from emotional stress. This trait is called *temperament*.

There have been a number of tests designed to measure temperament and some have been reported to be useful in industrial situations. The Humm-Wadsworth Scale is one of the better known temperament tests, but there are conflicting reports about it. Seven "components" of temperament are alleged to be measured by the scale. These are:

1. The *normal component*, or that typical of the self-controlled, well-balanced, and well-adjusted person.

2. The *hysteroid component*, which is manifest in ethically inferior motivation. The person with this component is selfish and engages in such antisocial behavior as lying, stealing, cheating, slander, etc.

3. The *manic-cycloid component,* which is characterized by emotionality, impatience, alterness, sociability, and wide interests.

4. The *depressive-cycloid component,* which is manifested by sadness, timidity, worry, and caution.

5. The *autistic schizoid component,* which is characterized by vivid imagination, shyness, hypersensitivity, and a tendency to live in a dream world.

6. The *paranoid schizoid component,* which is made up of stubbornness, fixity of ideas, egotism, rationalization, and suspicion of those who think differently.

7. The *epileptoid component,* which refers to meticulous planning, inspirational achievement, and self-directed activity.

These seven components of temperament are taken from Rosanoff's theory of personality as expressed in his book *Manual of Psychiatry.* They are the result of theoretical analysis rather than of experimental findings.

It is obvious that workmen who possess some of these temperament components in extreme amount are more easily bored in some situations than workmen who are more normal. For example, the workman with a strong hysteroid component would probably become easily bored with any sort of activity that did not have immediate personal value. Likewise, the workman with a strong manic-cycloid component probably would soon become bored with a simple punch-press job. On the other hand, the workman with a strong autistic component may enjoy short-cycle repetitive work because it would give him time to dream and would require little contact with other people. Theoretically, the workman's temperament should fit the type of work he performs if he is to experience a minimum of monotony.

Another test that measures temperament phases of personality is the Guilford-Martin Personnel Inventory. This test is in three parts and measures 13 factors, determined by the statistical analysis (factor analysis) of a large amount of test data.

The STDCR test measures social introversion, thinking introversion, depression, cycloid disposition, and rhathymia or impulsiveness. The GAMIN test measures general activity, ascendance (social leadership), masculinity, inferiority feeling, and nervousness. The third test measures objectivity, cooperativeness, and agreeableness.

The authors of both the Humm-Wadsworth test and the Guilford-Martin test report successful use of their respective tests in industrial situations. Humm claims that his scale will properly place more than

90 per cent of employees,[4] while Martin found that 75 per cent of employees can be properly placed by the use of the Personnel Inventory.[5] However, Dorcus found that the former test identified but 69 per cent of a group of good employees and 73 per cent of a group of poor employees. He found that the Personnel Inventory identified 73 per cent of the group of good employees and 68 per cent of the group of poor employees.[6]

The worth of these tests, as well as of other tests of temperament components of personality, depends on the truthfulness of the testee. If the testee is untruthful in answering any of the questions, the results are worthless. Equally important is the interpretation of the test results. Questionnaire inventories are too often loosely interpreted by users who have not had adequate experience in their use. Humm has properly criticized the use of his tests by psychologists who are not adequately trained for intelligent interpretation.[7]

MALADJUSTED APTITUDES

When men perform work with relative ease in comparison with other workmen and with themselves on other types of work, they are less likely to become bored than when they are performing work which is too difficult for them. Conversely, when they perform work that is too easy for their abilities, they become bored. The difficulty of work should be appropriate for the aptitudes of the workers.

Proper job placement has been discussed in Chap. 2. As described there, the first step was job analysis to discover what sort of a workman would best fit the job. The second step was to analyze workmen to discover which ones had the characteristics needed. These two steps are likewise essential in solving the problem of boredom. First, what does the job require, and second, who has those characteristics required to perform it properly? A review of Chap. 3 at this time will familiarize the reader with the basis for the solution of monotony problems. For every job, regardless of its repetitive and easy features, there is somewhere a workman who fits it and will enjoy its performance.

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[4] Humm, D. G., and Humm, K. A., Validity of the Humm-Wadsworth Temperament Scale, *J. Appl. Psychol.*, 1944, 28, 55–64.

[5] Martin, H. G., Locating the Troublemaker with the Guilford-Martin Personnel Inventory, *J. Appl. Psychol.*, 1944, 28, 261–467.

[6] Dorcus, R. M., A Brief Study of the Humm-Wadsworth Temperament Scale and the Guilford-Martin Personnel Inventory in an Industrial Situation, *J. Appl. Psychol.*, 1944, 28, 302–307.

[7] Humm, D. G., Discussion of Dorcus' Study of the Humm-Wadsworth Temperament Scale, *J. Appl. Psychol.*, 1944, 28, 527–529.

Some people are hard to please, others are easily satisfied. Some can more readily adjust to strange and unique situations. While all human nature is alike in certain respects, an outstanding human difference is the ease with which one can adjust to situations that do not fit him. This is usually referred to as intelligence. Wyatt and Langdon (quoted above) found that in routine jobs, such as soap wrapping, chocolate packing, and tobacco weighing, workmen who had low intelligence showed less evidence of boredom than did those of high intelligence. These differences were statistically significant. (The same investigators also found that the extroverted workman is more likely to be bored with routine work than the introverted workman.) Thompson[8] found that intelligence and emotional-stability tests correlated .71 with susceptibility to monotomy in a laboratory situation. The criterion of monotony, however, was reduced production rather than subjective feelings.

OTHER MALADJUSTMENTS

In addition to the maladjustment due to the innate traits of the workman, other maladjustments may cause his work to become boring. He may be maladjusted in his home, or his community, or his church. Anything that causes him to become dissatisfied may spread to his job and make him become dissatisfied with it, too. The dissatisfied worker becomes inefficient and bored with his work even when his dissatisfaction has nothing to do with his job or the company he works for. Cain[9] found that the monotony-susceptible worker is less contented with life and more poorly adjusted in his or her family than is the non-monotony-susceptible worker. The typical bored worker seems to dislike regularity of habits both on the job and outside of working hours. Cain's study suggests that boredom-susceptibility is an innate characteristic, however, and not a result of a developed maladjustment.

An impossible off-the-job adjustment often makes a routine job completely unendurable. During the recent war, a young workman received an Army draft deferment because of the essential nature of his job, that of tool grinding. While skilled, the work was routine. The supervisor observed that both the quantity and quality of this employee's work was becoming variable. There seemed to be "off days." The workman's absenteeism increased. Preliminary investigation revealed only that the workman considered his job "most uninteresting and boring." He expressed the desire to have his deferment annulled and to go into the Army. Because of the need for his services in meeting production schedules, his problem was then more carefully studied. It was found that the workman's mother had developed a serious lung infection and had to go to a tubercular sanitarium. Insufficient funds ruled out a private hospital and the state institution was apparently filled. This home problem made his job almost unendurable. Through company effort, the mother was admitted to the state sanitarium and the workman soon again became a proficient tool grinder.

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[8] Thompson, L. A., Measuring Susceptibility to Monotony. *Person. J.*, 1929, 8, 172–193.

[9] Cain, P. A., as reported by Ryan, R. A., *Work and Effort*, pp. 199*ff*. The Ronald Press Company, New York, 1947.

The files of any personnel office contain many records of similar cases. Off-the-job maladjustments make any work boring that does not require the entire attention of a workman. Even nonroutine work for which a workman's qualifications may be most appropriate is affected adversely by serious maladjustment. The importance of such maladjustments is more fully discussed in Chap. 14.

Lack of Interest

Boredom may be caused by lack of interest even among those who are not misfits on the job. It is true that most lack of interest is due to the fact that the man and the job do not fit. But even when they do, interest may be lacking. Uninteresting work is boring. In fact, the relationship is so close that lack of interest and boredom are often considered as one and the same thing. Barmack[10] refers to the "interested" and the "bored" groups in his laboratory studies of boredom. Whether the distinction is useful or not, it is generally agreed that so-called uninteresting work soon becomes boring for people whose IQ's or temperaments are not suited to it.

Inability to Daydream

Even the more routine work can be performed by some employees without being bored because they daydream while they are performing it. "Mind wandering" is a protection against monotony. Wyatt has said: "The worker who is able to daydream becomes oblivious to unpleasant realities and remains comparatively undisturbed by the unsatisfying features of repetitive work."[11] He found that production was greater while the worker was daydreaming than when he was not. In bicycle-chain assembly, where the work cycle was very short, he found that the average production was 32.2 units per minute while daydreaming, and only 29.6 per minute when "mind wandering was almost absent."

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[10] Barmack, J. E., Boredom and Other Factors in the Physiology of Mental Effort, *Arch. Psychol.*, 1937, No. 218.

Mental activity while working, however, may not be mere daydreaming in nature. It may be more constructive and more useful. Students find that they are not bored with repetitive, short-cycle work while they are in school. They have time to think over their school work, to plan for coming events, to reminisce about happenings just past, to absorb and comprehend the rapid-fire learning of the classroom. Working students often prefer repetitive easy work to that which requires more attention and which is considered by most workmen to be more interesting.

REMEDIES FOR BOREDOM

The best remedy for boredom, obviously, is to eliminate short-cycle repetitive work and easy work, and then to hire only workmen who do not possess undesirable work characteristics mentioned above. It is equally obvious that this is impossible. As explained in Chap. 5, the trend in industry is to simplify jobs by breaking them down into discrete operations, with each operation performed by a separate workman. Such division of labor results in greater production, and each operation is performed with less specific skill than was necessary when all work was performed by a single workman. Less training is required, there is less machine and tool idleness, and the over-all cost of production is reduced. However, the boredom of work is increased. The remedy for boredom cannot be the elimination of short-cycle and easy work.

"Round Pegs in Round Holes"

The workman must fit his job in every respect if boredom is to be kept at a minimum. Workmen differ in aptitudes and abilities, temperament, endurance, and tolerance for ordinarily boring work. As explained in Chap. 2, a job must be analyzed and understood thoroughly to determine what worker qualifications are appropriate for it. Then the worker must be analyzed by carefully planned testing, by a study of his past work record, and by an evaluation of his education and training. Worker qualifications can then be fitted to job requirements. Round pegs can then be placed in round holes and square pegs in square holes.

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[11] Wyatt, S., *et al.*, The Effects of Monotony in Work, *Industr. Fat. Res. Bd. Rept.*, No. 56, London, 1929.

While this procedure is of fundamental importance in the reduction of boredom, it has been discussed elsewhere in this book and further comment here would belabor the point. The reader is urged to review Chaps. 2, 3, and 4 in understanding the problem of placing the workman on the job for which he is fitted.

ALTERNATING WORK

Boredom is often relieved by workmen trading jobs. This is possible only when the work on two jobs can be performed with equal proficiency by both workmen. For example, a "nick-and-break" operation in a forge shop consisted of four jobs—nicking (with a torch), feeding, operating, and stacking. All were low grade semiskilled, short cycle, and required medium expenditure of energy. The daylight shift crew was composed of four college boys who were on summer vacation. In spite of good pay, they requested to be transferred to jobs that were less monotonous. However, they were asked first to rotate jobs each hour for a week. This meant that each man performed each job for an hour in the morning and an hour in the afternoon each day. At the end of the week the boys withdrew their request to be transferred. Many short-cycle jobs can be alternated in this way, thus relieving the inherent boredom.

However, the amount of production is not always benefitted by such procedure. Some workmen are more proficient at certain jobs in spite of feeling bored. Wyatt and Fraser[12] studied the effects of variety as compared with uniformity in production processes of soap wrapping, handkerchief folding, and bicycle-chain assembly. The differences were not great and not always in favor of the varied processes. Their results are summarized in Table 10–3. Another study by the same investigators found increased production due to variety in work ranging from 5 to 24 per cent and accuracy increasing from 9 to 55 per cent.

REST

As indicated in Chap. 8, rest has beneficial effects on production records. In some cases, the rest periods relieve boredom as evidenced by introspective reports of workmen as well as by increased production. Rest relieves boredom as well as fatigue. Wyatt[13] says: "There is not the least doubt that a rest of ten minutes duration, introduced about the middle of the work spell, tends to neutralize the unpleasant and unfavorable effects of repeated activity, and is capable of producing an increase in output from 5 to 10 per cent."

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[12] Wyatt, Fraser, and Stock, *op. cit.*

Rest, however, should not be considered as a proper *solution* for the boredom problem. Rest is a proper solution for fatigue but not for boredom. It is a time for the body to recover from the effects of activity. Poisonous effects of fatigue are given off, heartbeat slows down, blood pressure is reduced, temperature goes down, muscles are relaxed, and anabolic processes begin to repair the damage of catabolic processes. Such conditions do not exist in boredom. There are no fatigue conditions and no body repair is necessary. Rest is an uneconomical relief from monotony.

MUSIC

While the planned use of music during working hours to relieve feelings of boredom is comparatively recent in American industry, it has functioned for that purpose since before the beginning of recorded history. The "Whistle While You Work" song in *Snow White and the Seven Dwarfs* is suggestive of the function of music in our most primitive cultural background. Many folk songs are about work and were developed in work situations. The "sea chantey songs" concerned work activities of the old sailors who sang, first, to relieve boredom and, second, to provide uniform work cadence on such jobs as "reefing sail" which required the cooperative action of many hands. Many of our American Negro songs grew out of work situations and provide cadence especially appropriate to harmonious work. Army marching songs are examples of the use of music to relieve boredom. In 1876, John Wanamaker introduced a formal song period for his employees each morning before the store opened. The spontaneous songs of workmen thus began to be replaced by arranged music programs. A number of studies have now been made of such arranged music and its effect on the attitudes and production of workmen.

In 1921, Gatewood[14] found that a group of draftsmen were more efficient while music was being played. They enjoyed the music periods while working and expressed the desire to have the music continued. This was the first objective study of the use of music in industry.

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[13] Wyatt, S., Boredom in Industry, *J. Person. Res.*, 1929, 8, 121–171.

[14] Gatewood, E. L., An Experiment in the Use of Music in an Architectural Drafting Room, *J. Appl. Psychol.*, 1921, 5, 350–358.

In 1937, Wyatt and Langdon[15] reported a study of the effects of music on the production of 12 English girls making paper snappers. The increase in production due to music was small but statistically significant. The production with and without music was as follows:

Hours of music	Weeks	Production
1. None	6	100
2. 10–11:15 A.M., 4–5 P.M.	3	106
3. 9:30–10 A.M., 11–11:45 A.M., 4–5 P.M.	3	102.6
4. Alternate half hours A.M., 4–5 P.M.	2	104.4
5. None	5	Near 100
6. 10–11:15 A.M., 4–5 P.M.	5	106

Humes[16] studied the effects of music on the amount of scrappage in the manufacture of radio tubes. Without the knowledge of the employees, he compared five periods:

1. Mixed music—5 weeks
2. Slow music—3 weeks
3. Fast music—3 weeks
4. Arranged music—3 weeks
5. No music

He found that scrappage was greater in the no-music period than in any of the music periods. Both slow and fast music periods were superior to the mixed music periods, although nothing is said of the statistical significance of the differences. The employees were so enthusiastic in their preference for music while working that they objected to the no-music period.

Burris-Meyer is reported by Benson[17] to have found that music had a beneficial effect on both production and absenteeism in an unnamed industry. The average effect on production for the afternoon is shown in Fig. 10–1. Note that the typical midafternoon lag was eliminated.

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[15] Wyatt and Langdon, *op. cit.*, pp. 30–42.

[16] Humes, J. F., The Effects of Occupational Music on Scrappage in the Manufacture of Radio Tubes, *J. Appl. Psychol.*, 1942, 25, 373–387.

[17] Benson, Barbara E., *Music and Sound Systems in Industry*, p. 60, McGraw-Hill Book Company, Inc., New York, 1945.

One of the most thorough studies of the effects of music in industrial situations was made by Smith.[18] Varied amounts of music were used and the effects on employee attitude, production, and accidents were carefully checked. The work performed was radio assembly and more than a thousand employees (mostly women) were involved. There were three shifts working 6 days per week. Fifty-eight per cent of the employees were between 20 and 30 years of age. One day each week there was no music, 1 day there was 1 hour of music, 1 day there were 2 hours of music, 1 day 3 hours, 1 day 4 hours, and 1 day 5 hours. The pattern shifted from week to week so that Monday, for example, was a no-music day one week, the next week a 4-hour music day, the next week a 2-hour music day, the next week a 1-hour music day, the next a 3-hour music day, and the next a 5-hour music day. The experiment lasted for 8 weeks.

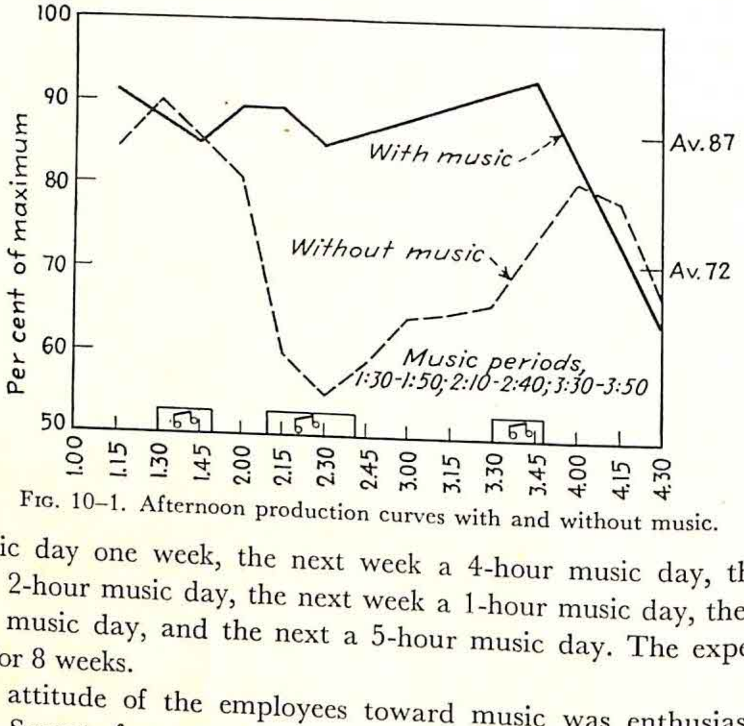

FIG. 10–1. Afternoon production curves with and without music.

The attitude of the employees toward music was enthusiastic approval. Seventy-four per cent said the music was "extremely pleasant." 22 per cent said it was "quite pleasant," 2 per cent termed it "mildly pleasant," and only 2 per cent did not care for it at all. The "no-music" day was the most unpopular of the week regardless of which day it fell on. About half the employees requested music "all the time," although 5 hours was the maximum duration of music in any 8-hour work period.

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[18] Smith, H. C., Music in Relation to Employee Attitudes, Work Production, and Industrial Accidents, *Appl. Psychol. Monogr.*, No. 14, 1947.

The average production on the music days exceeded that of the no-music days 17.3 per cent for the night shift and 7.2 per cent for the day shifts. These differences, however, were not all highly significant. The gains in production due to music and the confidence levels of those gains are shown in Table 10–4. The fact that the night shift showed more effects of music than the day shift may suggest that boredom is greater at night than in the daytime. However, Smith suggests that because the daily level of production was higher than that of the night shift, there was less room for improvement. Even with music the production of the night shift was still below that of the day shift without music. The average hourly production for the two shifts with and without music was as follows:

TABLE 10–4. PRODUCTION GAINS DUE TO VARIED AMOUNTS OF MUSIC AND CONFIDENCE LEVEL OF GAINS

Hours of music	Production gain		Confidence level, per cent
	Amount	Per cent	
Day shift:			
1	9.5	12.0	2
2	8.4	10.6	4
3	3.0	3.8	25
4	5.4	6.8	15
5	3.1	3.9	25
Night shift:			
1	8.0	13.2	10
2	12.0	19.8	1
3	9.6	15.8	5
4	14.9	24.5	0.3
5	8.1	13.3	2

Shift	No Music	Music
Day	79.1	84.8
Night	60.7	71.2

The influence of music on accidents was not so clear in this study. One shift showed a slight increase in accidents on music days (a difference significant at the 5 per cent level of confidence) but the influence of music on accident frequency for all three shifts was exactly zero.

SUMMARY

Some work is boring to most workmen. This is usually short-cycle repetitive work that is not difficult to perform. It soon becomes habitual and can be performed without mental effort or attention. It is the type of work that should be performed by a machine. It is drudgery work.

Some workmen get bored easily. They seem to be bored by any kind of work. They are usually maladjusted in some way. Either they are temperamentally unsuited for the work, or they do not have the necessary work aptitudes, or they have off-the-job troubles that carry over to the work situation, or they are just not interested in the work. Such people are easily bored and are not likely to stick to any job. They can often be detected by investigating the number of jobs held and the time spent on each, during a recent period, say 3 years.

The remedies for boredom depend on the conditions present in the situation. Sometimes the job can be changed to make it less boring; sometimes boredom-susceptible applicants can be detected and not hired; sometimes workmen can be placed on jobs that just fit their qualifications; sometimes boring jobs can be alternated; sometimes music can be introduced to make boredom more tolerable; and sometimes bored employees learn to daydream and perform boring work without being bored. It must be emphasized that modern industry is creating more and more short-cycle, semiskilled jobs as work simplification increases. The boredom problem is ever on the increase and requires more study than has been given it.

RECOMMENDED READINGS

BENSON, BARBARA, E.: *Music and Sound Systems in Industry*, McGraw-Hill Book Company, Inc., New York, 1945.

GHISELLI, E. E., and BROWN, C. W.: *Personnel and Industrial Psychology*, Chap. 15, McGraw-Hill Book Company, Inc., New York, 1948.

POFFENBERGER, A. T.: *Principles of Applied Psychology*, Chap. 10, Appleton-Century-Crofts, Inc., New York, 1942.

VITELES, M. S.: *Industrial Psychology*, Chap. 24, W. W. Norton & Company, New York, 1932.

Chapter 11

LIGHTING AND VENTILATION

- Lighting
  - Seeing Ability
    - Measurement of Seeing Ability
    - Prevalence of Defective Vision
    - Relation of Seeing Ability to Industrial Production
  - Reflecting Surfaces
    - Reflection Control by Painting
    - Glare
  - Lighting
    - The Quantity of Light
    - The Quality of Light
- Ventilation
  - Temperature Control
    - Methods of Insulation
    - Methods of Heating
    - The Amount of Heat
  - Humidity Control
  - Air-movement Control

The influence of music on the efficiency of workers was discussed in the last chapter. Safety factors were considered in Chap. 9. This chapter is limited to a review of the influence of two other factors which make up the working environment, lighting and ventilation. Both are too frequently ignored in the typical industrial situation. Workmen cannot produce efficiently under poorly lighted and poorly ventilated conditions. The cost of good lighting and good ventilation is less than the cost of human inefficiency caused by their absence.

LIGHTING

It is trite to say that the purpose of lighting is to make seeing less difficult and less fatiguing. It is equally trite to observe that the effectiveness of any light, whether artificial or natural, depends on the reflection qualities (colors, textures, etc.) of the surrounding media. Three factors, then, are interrelated in the lighting problem—seeing ability or vision, reflecting surfaces, and the nature of lighting itself. For industrial efficiency, all three merit careful attention.

Seeing Ability

The successful and safe performance of most jobs in industry necessitates normal seeing ability. One authority estimates that 85 per cent of all working movements are controlled by sight. Some jobs require exceptional ability in some phase of visual function. For example, inspectors of tin plates need superior ability in seeing small surface defects. Die polishers need keen vision to determine when their work has reached standard quality. Watch repairmen must have meticulous visual ability. On the other hand, many jobs can be performed successfully by workmen who are defective in visual function. The degree and nature of seeing ability required by a job are revealed by job analysis, discussed in Chap. 2.

Measurement of Seeing Ability.[1] It should be emphasized that the accurate measurement of seeing ability and the diagnosis of visual problems are primarily the functions of oculists and optometrists. The industrial psychologist is interested only in the use of those precision instruments which will enable him to screen those who have normal seeing ability from those who do not. Workmen who do not have normal visual ability can then be properly directed—sent to specialists who are trained and licensed to diagnose and prescribe corrective procedures, placed on jobs where normal vision is not required, or refused employment entirely.

Normal seeing ability is composed of four "visual skills" which can be measured with a fair degree of accuracy. They are keenness or acuity of vision, discrimination of distance (depth perception), discrimination of colors, and eye posture (phoria).

Keenness or acuity of distant vision can be measured by test charts, such as the Snellen chart or the American Medical Association chart. These are illustrated in Fig. 11–1. Normal distance acuity is determined by testing the ability of an individual to discriminate the letters on these charts at a specified distance (usually 20 ft.), the distance at which other people who are known to have normal vision can discriminate the letters. Each eye is tested separately. Near visual acuity is measured in much the same way except that the distance is nearer, usually 15 in. Instead of discriminating letters, as on the distance acuity charts, the test is reading print of 3-, 5-, and 7-point type.

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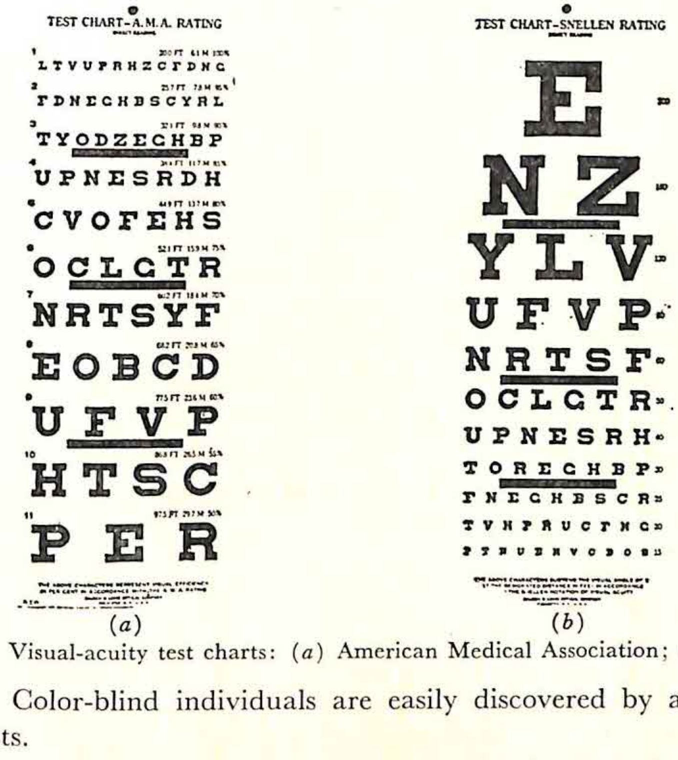
[1] A more complete discussion of the measurement of seeing ability will be found in Chap. 7 of the second edition of *Industrial Psychology* by J. Tiffin, Prentice-Hall, Inc., New York, 1947.

Discrimination of distance, or depth perception, can be measured in various ways. One method is to move two upright posts on a calibrated track by pulling attached strings until the posts appear to be equally distant. The error is then recorded. The posts are located in a tunnel so that certain distance cues (shadows, interposition, etc.) are eliminated.

Color discrimination can be measured by classifying colored yarns into color piles, or by arranging varied colored objects in serial order of hue differences, or by discriminating figures in multicolored backgrounds. Color-blind individuals are easily discovered by any of the above tests.



(*a*) (*b*)

FIG. 11–1. Visual-acuity test charts: (*a*) American Medical Association; (*b*) Snellen.

Phoria exists when both eyes are in normal balance during a condition of physiological rest, or nonconvergence. Deviation of either eye, either vertically or laterally, interferes with precision in seeing. This ability can be measured by the use of an old-fashioned stereoscope and rather simply constructed view cards.

All four of these visual skills may be measured with satisfactory precision by the use of any one of three refined stereoscopes and specially designed view cards. One is the *Telebinocular,* an instrument produced by the Keystone View Co., and the other is the *Ortho-rater,* produced by the Bausch and Lomb Optical Co. As described in an earlier section, the view cards for the Ortho-rater are contained within the instrument itself. Another instrument which functions on a somewhat similar principle is the *Sight-screener,* manufactured by the American Optical Co. A somewhat simpler and less expensive device for measuring visual skills is the *Eames Eye Test* distributed by the World Book Co. While it was devised for visual screening in the public schools, it has been used by this writer in industrial situations.

Some companies have developed visual requirements for each job in the form of "visual job profiles." They have determined how much acuity (both near and far), how much depth perception, how much color perception, and how much eye balance is necessary for proper job performance.[2] Men who do not meet the visual requirements of a job are not considered when recruitment is necessary. An example of such a profile is shown in Fig. 11–2.

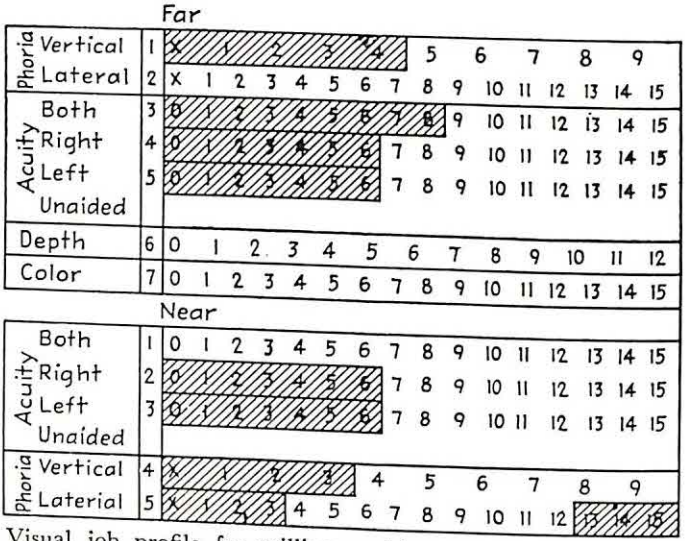


FIG. 11–2. Visual job profile for milling-machine operators. Shaded areas indicate unstisfactory scores.

Prevalence of Defective Vision. Defective vision is much more prevalent than is generally supposed, especially among workmen who are over forty years of age and who work at jobs requiring close visual attention for prolonged periods of time. The percentages of defective vision in various age and occupational groups are shown in Table 11–1.

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[2] See Chap. 8, *Principles of Personnel Testing,* by C. H. Lawshe, McGraw-Hill Book Company, Inc., New York, 1948.

TABLE 11–1. AVERAGE PER CENT HAVING DEFECTIVE VISION IN AGE AND OCCUPATIONAL GROUPS

Age	Per Cent	Occupation	Per Cent
Under 20	23	Common labor	10
20–30	39	Public schools	22
30–40	48	Carpenter	30
40–50	71	Colleges	40
50–60	82	Machinist	50
Over 60	95	Housewife	70
		Draftsman	90

Of course, a large number of workmen with defective vision already wear corrective glasses but there are enough who do not to make visual screening tests necessary. A workman with defective vision is too easily detected and too much of a potential safety hazard (as well as an inefficient workman) to justify a hands-off policy toward this handicap. A simple test will discover that a workman has defective vision and justify the requirement that he see an eye specialist. If he is an applicant for employment, further consideration can be delayed until he has gotten corrective glasses. If he is already employed, further advancement can be made conditional on the correction of his visual handicap.

Relation of Seeing Ability to Industrial Production. In general, those workmen who have defective vision are less proficient than are those who have normal vision. They are also less proficient with uncorrected visual defects than they are after their visual handicap has been corrected. Wirt[3] found that workmen who had had eye care were able to adjust to peacetime production (following the Second World War) with less difficulty than were those who did not receive eye care. A group of electric solderers who had had no eye care experienced a loss of production equivalent to 4 cents per hour, while a group who had had eye care had no loss in production following reconversion. Stump[4] found that the most proficient workmen, as indicated by their earnings per hour, are better able to pass visual tests than are those who are less proficient. Table 11–2 shows the percentage of workmen at four earning levels who were able to pass visual tests. Certainly defective vision at the lower levels has some causal relation to the reduced proficiency.

Tiffin[5] studied the production curves of two groups of loopers in a

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[3] Wirt, S. E., Eye Care Increases Earnings of Electric Solderers, *Optom. Wkly.*, 1946, pp. 1091*ff*.

[4] Stump, F. N., Vision Tests Predict Worker Capability, *Fact. Mgmt. and Maint.*, 1946, **104**, 121–124.

[5] Tiffin, *op. cit.*, p. 233.

TABLE 11–2. WORKMEN IN VARIOUS EARNING BRACKETS WHO PASSED VISUAL TESTS

Earnings per Hour	Per Cent Passing
$0.90–1.05	96
0.80–0.85	78
0.65–0.76	55
0.25–0.60	40

hosiery mill before and after an increase in the hours worked. One group wore corrective glasses and the other did not. While the average production rate for both groups decreased, the group that wore glasses were able to make a better adjustment to the increased hours. They were below the control group in production rate before the hours increased, but they soon surpassed them. These data are shown in Fig. 11–3.

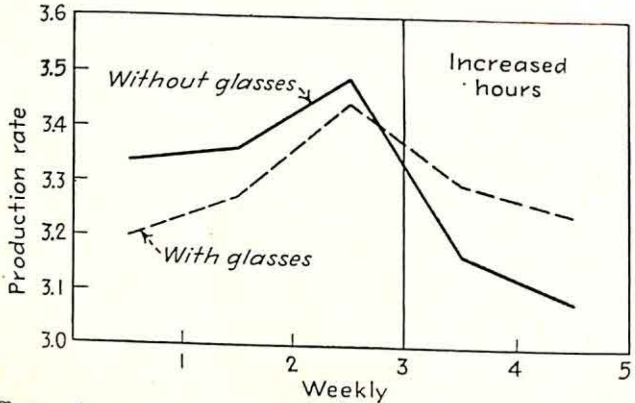

FIG. 11–3. Effects of increased hours on production of two groups of loopers in a hosiery mill.

Wirt and Leedke[6] matched 52 workmen in a paper mill who had had one or more serious accidents with 52 workmen who had not had a serious accident and gave vision tests to the entire group of 104. They found that 63 per cent of the no-accident group passed the tests while only 33 per cent of the accident group passed. With similar groups of millwrights, 36 per cent of the no-accident group passed visual tests while only 19 per cent of the accident group passed. This study showed the importance of good vision in safety records, but it also showed the appalling prevalence of poor eyesight among industrial workmen. Only 48 per cent of the paper-machine operators and 27 per cent of the millwrights (both the accident and the no-accident group) were able

[6] Wirt, S. E., and Leedke, H. N., Skillful Eyes Prevent Accidents, *Nat. Safety Coun., Industr. Nursing Sec., News Letter*, 1945.

to pass the vision tests. Certainly visual ability receives too little attention in American industry.

Coleman[7] studied the relation of visual ability, as measured by the Ortho-rater, to production efficiency among assemblers of precision instruments. He found that the job performance of those who could pass the vision tests surpassed that of those who could not. His results are shown in Table 11–3. A somewhat similar study was made by Ayers[8] with inspectors in textile mills. He found a correlation of .75 between visual-ability tests and erroneous inspection of rayon yarn cones. Those inspectors who were inferior on the visual tests were also inferior inspectors. Ayers' results are shown in Fig. 11–4.

TABLE 11-3. VISUAL ABILITY IN RELATION TO JOB PERFORMANCE

Performance	Visual skills tests	
	Passed, per cent	Failed, per cent
Poor	12	9
Fair	14	19
Average	29	42
Good	25	19
Excellent	20	11

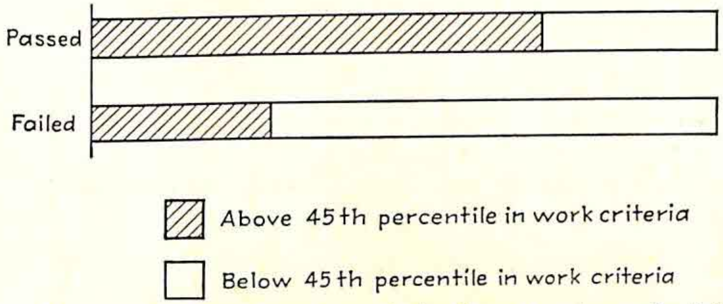

FIG. 11–4. Relation of workmen who passed visual tests to those who failed visual tests in work proficiency.

It is obvious from these studies that visual ability is important to success on many jobs. Those workmen who have inferior visual skills are inferior workmen on jobs where vision is important. It should be noted, however, that when inferior workmanship is due to visual handicaps it can be improved by visual correction. Few human handicaps are more easily and more adequately corrected than are those of vision. It is the function of the industrial psychologist to screen out those who have visual handicaps and then effect either a remedy of the handicap or transferral to a job requiring less visual ability.

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[7] Coleman, J. H., The Visual Skills of Precision Instrument Assemblers, *J. Consult. Psychol.*, 1945, 9, 165–170.

[8] Ayers, A. W., A Comparison of Certain Visual Factors with the Efficiency of Textile Inspectors, *J. Appl. Psychol.*, 1942, 26, 812–827.

Reflecting Surfaces

Light from the sun passes through space devoid of any reflecting media (such as objects, dust particles, moisture droplets, etc.) and is said to afford but little light in those areas. As it nears the earth it is reflected by dust particles and moisture droplets so that objects on the earth's surface are lighted by rays coming from all directions. This is called "diffused light." The best lighting from the standpoint of eye fatigue is that which is diffused, or reflected, from all directions.

The controllable factors in diffusing light in an industrial situation (aside from the light source itself, which will be discussed in the next section of this chapter) are the walls, ceilings, floors, and objects in the work area. The reflecting value of these depends on their colors and surface textures. Colors are easily controlled by paints but, unfortunately, in most industrial situations this fact is completely ignored. Walls are unpainted and machinery is covered with dirt and grime. Light from any source whatever is absorbed and seeing is difficult. Contrast this with the modern industrial situation where all surfaces higher than 8 feet above the floor are painted white, walls lower than 8 feet are painted in pastel shades of high reflection values, floors are painted in shades of gray with bright border strips to indicate traffic areas, and machinery is painted in varied colors to make switches, levers, gears, templates, etc., more clearly obvious and controllable. In short, paint is used to make lighting more effective and seeing less difficult.

Reflection Control by Painting. The colors that should be used in painting the interior of an industrial plant depend on three factors: the adequacy of the light (whether natural or artificial), the reflective value of various colors, and the amount of eyestrain necessitated by the work itself.[9]

If the work space is dark and inadequately lighted, it is then necessary to use only white paint so that a maximum amount of light will be reflected. A poorly lighted space can become better lighted by the use of white paint. On the other hand, if the work space is already adequately lighted, mild colors can then be used even though they absorb some light. Subdued shades of green and bluish-green have the psychological effect of "coolness." Because most work is active and causes the body to become heated, the cooling "feel" of pastel green is appreciated by workmen. In planning the color scheme for a work location, it is important to know the reflective values of the various colors. These are shown in Table 11–4. Colors of low reflective value should not be used with inadequate lighting. Note that even white absorbs 16 per cent of the light striking it.

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[9] For an excellent discussion of the value of paint in industrial situations, see *Color Dynamics,* distributed by the Pittsburgh Plate Glass Company.

TABLE 11–4. REFLECTIVE VALUES OF VARIOUS PAINT COLORS

Color	Per Cent
White	84.0
Cream	68.8
Ivory	66.7
Light pink	66.5
Sky blue	65.0
Yellow	57.0
Flesh	51.6
Buff	51.5
Light gray	51.5
Light green	45.2
Aluminum gray	41.0
Light blue	36.4
Sage green	36.3
Brown	27.5
Dark red	13.8
Dark green	9.2
Dark blue	8.4

Work that requires close visual attention should be well-lighted so that colors of high reflective value are not necessary. More important here is to have colors in the background that are restful to the eyes when the workman looks up from his task. The value or intensity of these colors should not vary greatly from that of the work materials. If the machine is dark and the back wall is light, the eye must then make an adjustment when it moves from one to the other. Marked differences in brightness any place in the visual field cause eye fatigue. Ideal ratios are 1 to 3 but should never exceed 1 to 10. When lighting is adequate, all surfaces in the visual field are mild and tinted just enough to produce visual rest.

There is one exception to the rule that objects within the visual range should not vary in brightness more than 1 to 10. If the materials to be seen are small, they can be seen more easily if they are shown against a background of high contrast. For example, white thread can be seen more easily against a black background, and black thread can be seen more easily against a white background. These words are more easily read because they are black on white than they would be if the contrast in brightness were less between the letters and their background. If these words were printed in black ink on blue paper instead of white, it would take approximately 60 ft.-c. of light intensity to make them as visible as they are now under 10 ft.-c. However, in other parts of the visual range, the brightness contrasts should be as small as possible.

Glare. When surfaces are bright and smooth, whether painted or unpainted, they reflect light in one direction only. This is called "reflected glare" and reduces visibility. Nonglare surfaces reflect light in many directions and do not reduce visibility. Water, glass, glossy paper, polished metals, and white enameled surfaces tend to produce this sort of glare. Glare may also occur when light sources are near the objects being viewed. This is called "direct glare." The headlights of an approaching car produce direct glare, as does an unshaded light in front of a workman. Either reflected or direct glare reduces the amount of effective light and makes seeing more difficult. This is illustrated in Fig. 11–5.[10] Part I of the figure shows a no-glare seeing situation in which 10 ft.-c. of light fall on the object. Part II shows a glare light source of 5 ft.-c. appearing at a 20-deg. angle above the line of vision. This causes a light loss of 53 per cent which means that the object is now being viewed in but 4.7 ft.-c. of light. Part III shows the same situation with the same 5 ft.-c. of glare but now moved down to 5 deg. above the line of vision. This causes a light loss of 84 per cent and reduces the effective light on the object to but 1.6 ft.-c. Obviously, glare is more harmful to effective vision when it is close to the object being viewed. The further it is from the line of vision, the less harmful it is to the seeing process.

Where smooth, bright objects cannot be eliminated from the field of vision, glare can be controlled by diffusing the light before it reaches the objects. This is discussed below under the topic Indirect Lighting.

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[10] This is a modification of Fig. 113 in Luckiesh, M., and Moss, F. K., *The Science of Seeing*, p. 390, D. Van Nostrand Company, Inc., New York, 1937.

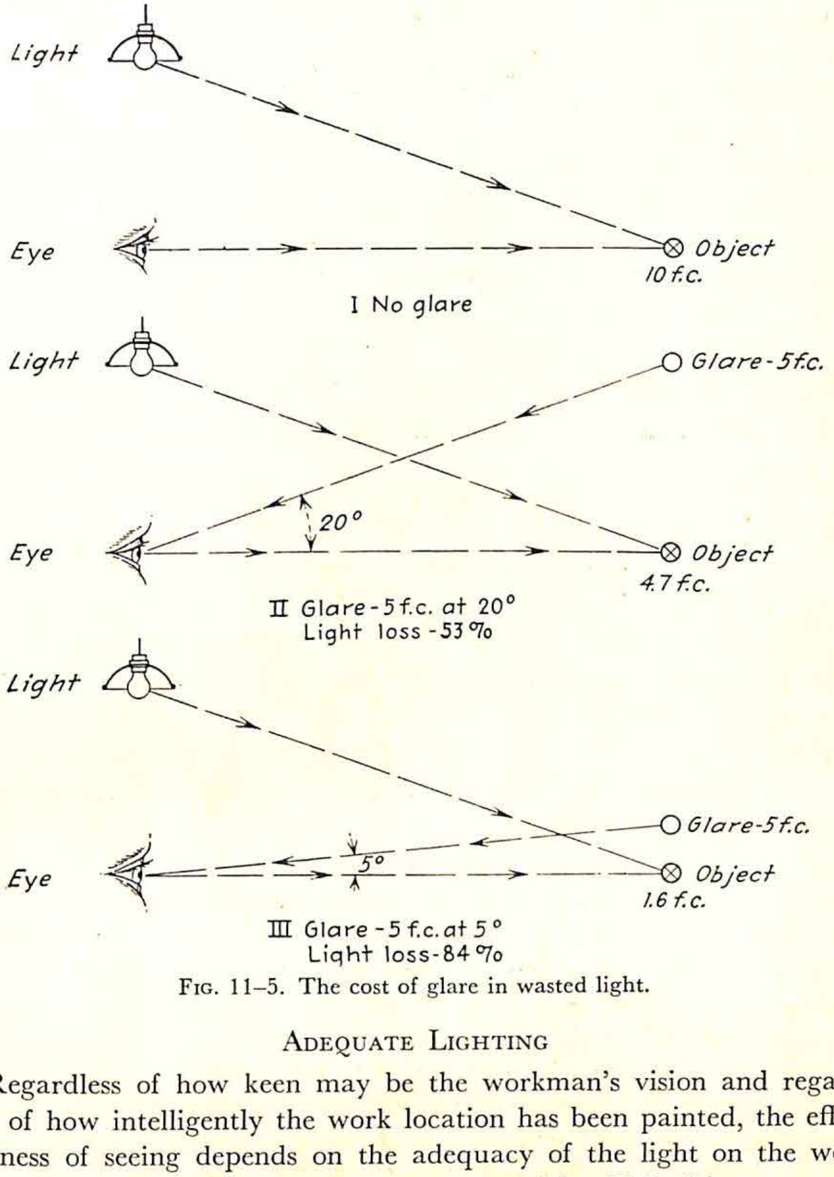

FIG. 11–5. The cost of glare in wasted light.

ADEQUATE LIGHTING

Regardless of how keen may be the workman's vision and regardless of how intelligently the work location has been painted, the effectiveness of seeing depends on the adequacy of the light on the work area. Two factors are important—the ease with which objects are seen and freedom from fatigue produced by the process of seeing. The first is largely taken care of by the intensity of light; the second, by the diffusion of the light. There should be plenty of light, and it should be well diffused throughout the visual range.

The Quantity of Light. The amount or quantity of light depends on the nature of the work being performed. If there is fineness of detail to be observed and a high degree of accuracy necessary, the amount of light should be correspondingly great. If the work is with large objects and accuracy is not essential, a less amount of light is sufficient. Older people need more light for a given accuracy of visual discrimination than do young people. People with visual defects need more light than do those who are not so handicapped. A reasonable increase in the amount of light beyond that necessary for visual discrimination will afford human comfort and cause less visual fatigue.

The intensity of illumination recommended for various types of work is something of a moot question. Luckiesh and Moss[11] make "conservative foot-candle recommendations" for various types of activity. These are shown in Fig. 11–6 and described as follows:

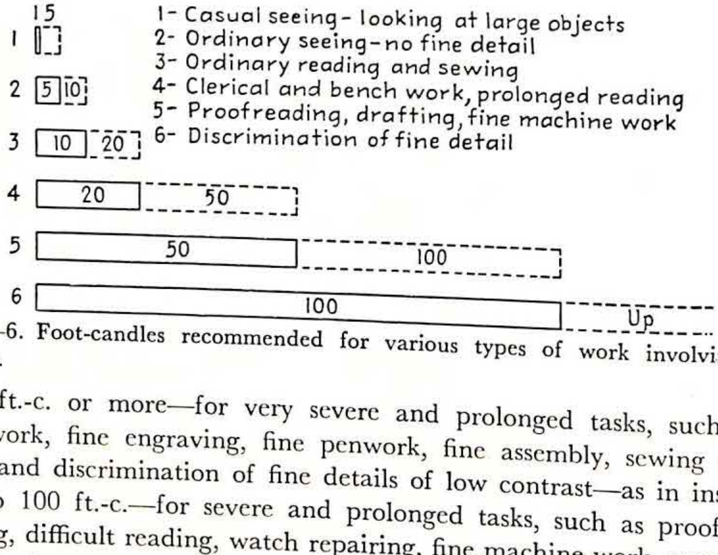

FIG. 11–6. Foot-candles recommended for various types of work involving visual function.

100 ft.-c. or more—for very severe and prolonged tasks, such as fine needlework, fine engraving, fine penwork, fine assembly, sewing on dark goods, and discrimination of fine details of low contrast—as in inspection.

50 to 100 ft.-c.—for severe and prolonged tasks, such as proofreading, drafting, difficult reading, watch repairing, fine machine work, average sewing and other needle work.

20 to 50 ft.-c.—for moderately critical and prolonged tasks, such as clerical work, ordinary reading, common benchwork, average sewing and other needlework on light goods.

10 to 20 ft.-c.—for moderate tasks of office and factory when not prolonged, ordinary reading, and sewing on light goods.

5 to 10 ft.-c.—for visually controlled work in which seeing is important but more or less interrupted or casual, and does not involve discrimination of fine details or low contrasts.

1 to 5 ft.-c.—satisfactory for perceiving larger objects and for casual seeing.

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[11] Both from the Lighting Research Laboratory of the General Electric Company.

Presumably these recommendations are based on the rather elaborate research in the Lighting Research Laboratory of General Electric on "preferences for light intensity, visual acuity, frequency of blinking, heart rate while reading under varied foot-candle intensities," etc. Some of the results of these studies are shown in Table 11–5.

TABLE 11-5. VARIABLE FACTORS UNDER THREE LEVELS OF ILLUMINATION

	Foot-candles on object or task		
	1	10	100
Visual acuity, per cent	100	130	170
Contrast sensitivity, per cent (brightness contrast—7–32 per cent)	100	280	450
Frequency of blinking after reading 1 hour, per cent	100	77	65
Muscular tension while reading, grams	63	54	43
Decrease in heart rate while reading 1 hour, per cent	10	...	2
Decrease in convergence reserve of ocular muscles after reading 1 hour, per cent	23	...	7

The American Recommended Practice for School Lighting[12] is 15 ft.-c. for classrooms, shops and offices; 25 for sewing and drafting rooms; and 30 for sight-saving classes. More recently Sturrock[13] has recommended 30 ft.-c. for classrooms, study halls, laboratories, and general shops; 50 for drafting rooms, some laboratories, and sight saving classes; and 100 for close work in shops and sewing rooms.

These light intensities have been criticized by Tinker[14] as being higher than necessary for visual efficiency. His studies show that the "critical levels of illumination" (the intensity beyond which there is no further increase in efficiency of performance as the foot-candles become greater) are as follows:

Reading legible 6-point print—adults	3–4 ft.-c.
Reading legible print—children	4–6 ft.-c.
Reading newspaper print	7 ft.-c.
Sorting mail	8–10 ft.-c.
Setting 6-point type by hand	20–22 ft.-c.
Work similar to threading a needle	30 ft.-c.

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[12] *Illum. Eng. Soc. and Amer. Inst. Arch.*, New York, 1938, p. 60.

[13] Sturrock, W., Levels of Illumination, *Mag. of Light*, 1945, 14, 26–36.

[14] Tinker, M. A., Illumination Standards for Effective and Comfortable Vision, *J. Consult. Psychol.*, 1939, 3, 11–20.

If the visual function is prolonged, Tinker recommends that these intensities be increased, perhaps even doubled. He doubts, however, that it is ever necessary to have over 50 ft.-c. of light intensity for adequate visual discrimination. Darley and Ickis[15] found that in the drafting room any increase in light intensity over 50 ft.-c. was not accompanied by corresponding increase in efficiency ratings.

In industrial situations, however, there are few examples of light being wasted because of overintensities. Most studies indicate that present light intensities are too low for maximum production when other factors are held constant.

Luckiesh and Moss[16] increased the intensity of illumination, on a key-punching operation, from 8 to 60 ft.-c. with the result that production increased and errors decreased almost immediately. The results are shown in Fig. 11–7. Note that after the initial spurt of improvement there was a plateau of no improvement and then another spurt. The same authors summarize a series of studies of the effects of increased illumination intensity on production. These are shown in Table 11–6. In every case, the increase in production is far greater than the slight increased cost of lighting. Obviously, adequate illumination intensity more than pays for itself in increased production.

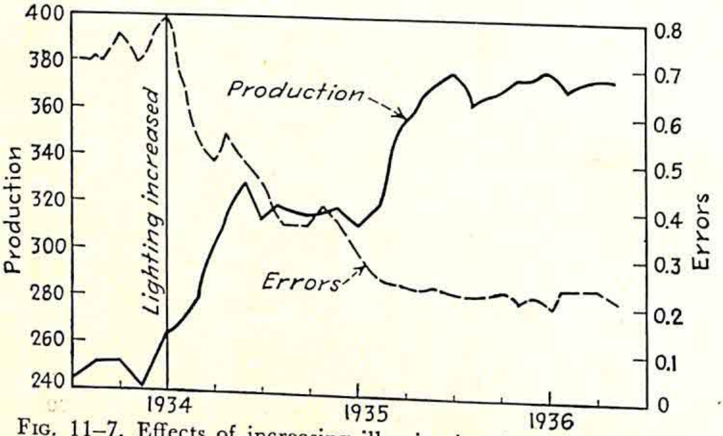

FIG. 11–7. Effects of increasing illumination from 8 to 60 ft.-c.

An old study of typesetting by Weston and Taylor[17] supports the

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[15] Darley, W. G., and Ickis, L. S., Lighting and Seeing in the Drafting Room, *Illum. Eng.*, 1941, 36, 1462–1487.

[16] Luckiesh and Moss, *op. cit.*, p. 275.

[17] Weston, H. C., and Taylor, A. K., Joint Report, *Industr. Fat. Res. Bd. Rept.*, London, 1926.

TABLE 11-6. TYPICAL EXAMPLES OF THE EFFECTS OF INCREASED ILLUMINATION INTENSITY ON PRODUCTION

Job	Foot-candles		Increased production, per cent	Increased lighting cost, per cent of payroll
	Old	New		
Pulley finishing	0.2	4.8	35	5.0
Soft metal bearings	4.6	12.7	15	1.2
Heavy steel machinery	3.0	11.5	10	1.2
Carburetor assembly	2.1	12.3	12	0.9
Electric and gas iron manufacturing	0.7	13.5	12	2.5
Semiautomatic buffing shell sockets	3.8	11.4	8.5	1.8
Letter sorting	3.6	8.0	4.4	0.6

results quoted above. They found that it was necessary to increase the intensity of artificial illumination to 25 ft.-c. before the errors were reduced and the quantity of work increased to levels comparable to daylight. Their results are shown in Table 11–7.

TABLE 11-7. EFFECTS OF INCREASED ARTIFICIAL ILLUMINATION ON TYPESETTING

Foot-candles	Errors	Quantity
1.3	1.41	76
6.8	0.79	88
14.0	0.69	94
24.5	0.62	101
Daylight	0.61	100

The Quality of Light. Equally as important as the intensity of light is the diffusion of light. All areas within the visual range should be of nearly the same brightness. When the eyes move from one object to another, major adaptation should be unnecessary. It is too commonly believed that if the work area is adequately lighted, the brightness of the surrounding area is unimportant. The college student of the last generation used an old fashioned gooseneck study light which threw a narrow spotlight on his book while the rest of the room was in comparative darkness. Similar lighting arrangements are found in too many machine shops today. Visual fatigue is caused by inadequate light intensity *anyplace* in the visual field. When light is adequately diffused, it is more equally scattered and the entire visual field is lighted. Then, if the intensity of the light is adequate and all objects are properly painted so that differences in reflection are not great (ratios in the neighborhood of 1 to 5), there will be a minimum loss in visual acuity due to fatigue.

The diffusion of light is largely determined by the degree to which it is indirect, that is, the degree to which it is reflected from all directions. When light is properly diffused there are no shadows, no dark corners, and no areas of relatively high brightness. The diffusion of light is determined by the pattern or nature of light source. Northern side windows will eliminate the directness of daylight, but the light intensity decreases rapidly with the distance from the windows. Sawtooth sky windows with northern exposure are more satisfactory. They distribute the light more evenly throughout the room. Supplementary artificial lighting is also used to correct low light intensities of work areas too far from windows to receive adequate daylight intensity. Some investigation has been done by Harmon[18] in schoolroom situations with cotton-fabric diffusion screens placed at oblique angles on side windows. The purpose is to reflect light first to the ceiling and then to areas further back from the windows. The screens are so placed that the light intensity of areas near the windows is reduced. This means that intensity ratios of areas near windows to areas near inside walls are reduced. Harmon reports ratio reduction from 18 to 1 to 8 to 1. He also claims to have reduced the brightness ratio of the upper window area to the upper inside wall area from 217 to 1 to a mere 8 to 1.

Glass blocks have been used instead of windows with reported satisfactory results from the point of view of daylight diffusion. The blocks cut the light intensity near the outside wall and diffuse it more evenly over the room. This is probably the best solution for daylight lighting if forced ventilation can be used.

While indirect daylight is the best form of lighting, it is sometimes impractical. Buildings often have inadequate window space, work areas are frequently so far from windows that daylight cannot reach them with adequate intensity,[19] daylight varies greatly on account of cloudiness, and the nature of the work often requires such a degree of light control that daylight is unsatisfactory. Artificial lighting is being used more and more in industry, and with recent improvements it is more and more satisfactory.

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[18] Harmon, D. B., Light on Growing Children, *Arch. Rec.*, February, 1946, pp. 78–90.

[19] The intensity of light decreases inversely as the square of the distance from the light source.

Many studies have been made of the effects of various degrees of light diffusion on eye fatigue. In general, they indicate that eye fatigue is inversely related to the directness of light. Indirect light is less fatiguing than direct light. The worst form of lighting is the exposed light element which shines directly on the area of vision. It causes excessive eye fatigue, as indicated by loss in acuity, after prolonged visual function. Slightly less fatiguing is the semidirect or diffused light, in which a part of the light intensity is direct and part is from reflection. This is usually accomplished by a light fixture which filters the light, allowing some of it to shine through and the rest to be reflected in other directions. Studies indicate that this type of lighting also causes eye fatigue after prolonged visual function. Much less fatiguing (the nearest approach to daylight) is that lighting which is completely indirect. The light source is unexposed to the visual area. The light intensity is entirely from reflection. An indication of such lighting is the absence of shadows. Ferree and Rand[20] studied these three forms of lighting (direct, semidirect, and indirect) together with daylight, in relation to visual acuity after 2 and 3 hours' reading. Their results are shown in Table 11–8. This is an old study and only the old incandescent lights were used.

TABLE 11–8. EFFECTS OF VARIOUS TYPES OF LIGHTING ON VISUAL ACUITY

Type of lighting	Per cent distribution		Per cent loss in acuity after	
	Up	Down	2 hours	3 hours
Daylight	......	......	5	6
Artificial light:				
Indirect	90–100	0–10	10	9
Semi-indirect	60–90	10–40	34	72
General diffuse	40–60	40–60		
Semidirect	10–40	60–90		
Direct	0–10	90–100	37	81

The fatigue effects of modern lighting methods, especially fluorescent, under controlled conditions have been studied by Gray and Prevetta.[21]

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[20] Ferree, C., and Rand, G., The Power of the Eye to Sustain Clear Seeing under Different Conditions of Lighting, *J. Educ. Psychol.*, 1917, 8, 451–468.

[21] Gray, J. S., and Prevetta, P., Fluorescent Light versus Daylight, *J. Appl. Psychol.*, 1950, 34, 235–236.

They compared the effects of 2 hours' continuous reading of 6-point type under 20 ft.-c. of daylight, with direct fluorescent light of the same intensity. So far as possible, all variables were kept constant except the source of light. The same subjects were used for both reading sessions; both reading periods were before noon; both daylight and fluorescent light came from the rear at approximately right angles to the reading page; and the reading material was held on an easel at right angles to the reader's line of gaze. The American Optical Company's Sight-screener was used to measure acuity, phoria (both horizontal and vertical), and depth perception of each subject before reading began, at the end of 1 hour, and at the end of 2 hours, for each reading session. These measurements were taken at both near (14 in.) and far (20 ft.) distances. The results are summarized in Table 11–9. None of the differences were statistically significant. Fluorescent light of 20 ft.-c. produces no more visual fatigue after 2 hours' continuous reading than daylight when its intensity is held at 20 ft.-c.

TABLE 11–9. VISUAL EFFECTS OF 2 HOURS' READING UNDER DAYLIGHT AND FLUORESCENT LIGHT FOR 50 SUBJECTS

Trait	Type of lighting, mean change ‡	
	Daylight	Fluorescent
Near distance (14 in.):		
Acuity*	−.04	−.12
Stereopsis*	.08	.00
Lateral phoria †	−.31	−.02
Vertical phoria †	−.01	.05
Far distance (20 ft.):		
Acuity*	−.04	.02
Stereopsis*	−.20	−.20
Lateral phoria †	−.26	−.21
Vertical phoria †	−.02	.11

* Data in "units of change."

† Data in diopters.

‡ Minus signs indicate loss.

This discussion of lighting may be summarized by stating some of the characteristics of good seeing conditions.

1. The ratio between the source of light (a window if daylight, a lighting fixture if artificial) and surrounding surfaces should be as small as possible. This can be controlled in part by increasing the light-source area without increasing (perhaps even decreasing) the light-source

intensity. More windows will cut down the brightness ratio by increasing the brightness of the darker areas. Many light fixtures scattered throughout a room will produce a lower brightness ratio than will a single fixture of high intensity. This is one factor in favor of fluorescent light fixtures. The light source covers a greater area than is true with incandescent light fixtures of the same intensity.

The brightness ratio between the light source and surrounding surfaces can also be controlled by making the light more indirect. Reflected light diffuses rapidly and all areas are more likely to have the same brightness.

A third factor that will reduce the brightness ratio between the light source and surrounding surfaces is to increase the brightness of surrounding surfaces by white paint. It is the contrast in brightness that causes eye fatigue.

2. The ratio between the brightness of various objects in the visual area should be low. It is a bad seeing condition to read this book against a dark background, whether it be your desk top, the carpet in the room, or just a dark area. The whole visual field should be of approximately the same brightness. A dark-colored desk constitutes a poor seeing condition when other objects in the room are brighter.

3. The objects looked at should be brighter than other objects within the visual range. This can be brought about in two ways—by painting the objects to be looked at in a brighter shade than other objects and by supplementary lighting. Whichever method is used, the brightness of the objects in the focus of vision should not be brighter than other objects in the visual range by a ratio of anymore than 8 to 1.

4. Exception to limited brightness ratio is justifiable when objects to be seen are so small that they are near the threshold of visual acuity. Small white thread can be seen more easily against a black background, and small black thread can be seen more easily against a white background. While this constitutes an eye strain, it is necessary for acuity. In seeing situations of this nature, the eyes must be rested frequently by looking away at surfaces of mild pastel shades.

VENTILATION

The effect of the condition of the atmosphere on human efficiency is illustrated in Fig. 1–6 in Chap. 1. Note that the production rate in August, for those jobs included in the study, was only 94 per cent of the year's average, while that for January was 104.4 per cent of the year's average. Dexter[22] found a similar seasonal relationship with errors in the calculations of bank clerks, although the fall months exceeded those in the summer in percentage of errors. (This was perhaps due to the depletion of energy resulting from the hot summer weather.) Such variation of seasonal output can be explained only by the concomitant variation in climate. The yearly temperature curve and the yearly production curve vary inversely in almost perfect relationship in many industries. In cold weather, production is high; in warm weather, production is low; in temperate weather (spring and fall), production is average.

This close relationship between production and atmospheric condition makes it profitable to control this factor artificially so that production can be kept at a maximum. "Air-conditioning" is the process of maintaining constant atmospheric conditions within a building regardless of the conditions outside. Therefore, seasonal changes outside need not affect the atmospheric conditions inside if a building is air-conditioned.

The reason one atmospheric condition is better than another is that it enables the body more easily to maintain a constant temperature of 98.6°F. This thermal homeostasis is maintained by perspiration when the body temperature is high and by increased oxidation when it is low. The effectiveness of sweating depends on its rate of evaporation, and this, in turn, depends on the temperature, the humidity, and the movement of the surrounding atmosphere. All three are closely interrelated and may produce a given amount of evaporation in many combinations. Ventilation control (air conditioning), then, depends on the control of its three interdependent factors—temperature, humidity, and air movement.

TEMPERATURE CONTROL

The artificial control of temperature is as old as civilization itself. The fire in the center of the Indian's wigwam serves fundamentally the same purpose as the thermostat-controlled gas furnace with automatic forced air circulation of the modern home. Many of the same advantages and many of the same limitations are characteristic of both. The wigwam is not heated at uniform temperature throughout. Near the fire and up near the top, the temperature is higher than near the outer wall and down near the floor (or ground). This unevenness of temperature is due to two factors: the infiltration of cold air from the outside and the presence of cold surfaces within the living area. Similarly, the modern home is not heated evenly throughout. Areas near the walls and near the floors are colder than areas near the ceiling and near the heat source—radiators, registers, or other heat elements. This unevenness in temperature is due also to the infiltration of cold air and the presence of cold surfaces within the living area.

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[22] Dexter, E. G., *Weather Influences*, The Macmillan Company, New York.

These two forms of heat *loss* in cold weather also account for heat entrance in warm weather.[23] A system of air cooling is efficient only to the degree that warm-air infiltration and the presence of warm surfaces within the room are controlled. These two forms of heat (or cold) loss are called *convection* and *conduction*. Convection is the movement of hot or cold air, and conduction is the transferance of heat through solid objects. (If one end of an iron rod is placed in a fire the other end gets hot by conduction.) Walls, windows, and ceilings are common heat-conduction media and account for much heat loss in the winter and heat entrance in the summer.

Methods of Insulation. Air (either hot or cold) infiltration is controlled in the modern home or industry by weather stripping around doors, windows, and entrance vestibules and by generally tight construction. Modern building methods have reduced air infiltration to a negligible amount.[24]

Conduction of heat, inward in summer and outward in winter, is controlled by various methods of insulation. Wall and ceiling conduction is reduced in two ways—covering with blankets of loose materials affording dead air space or using building materials that are poor heat conductors. The kind of loose material used for blanket insulation is relatively unimportant. Disintegrated minerals, spun glass, balsam, cotton, and other such substances are used in wool-like form to provide the blanket of dead air. The insulating effectiveness depends on the thickness of the layer of dead air and has nothing whatever to do with the material used to construct the blanket. Even snow makes excellent insulation, as evidenced by the experience of those who live in the frigid zones.

Building materials differ greatly in their heat insulation values. One inch of fiberboard, often used for sheathing, has the same insulation value as 4 ft. of concrete or stonewall. Iron is a good heat conductor and has but little insulation value. Wood, the most common building material, is of moderate insulation value. However, adequate wood thickness for insulation would be far beyond that necessary for structural rigidity. Perhaps the best construction from the standpoint of heat insulation is "hollow wall," with an outside veneer of masonry or other durable material. The space between the upright studs can then be filled with some form of blanket insulation, or lined with aluminum foil. (The latter type of insulation is effective only so long as the material maintains its reflective value.) Solid wall construction is usually poor insulation against the free passage of heat and consequently makes the maintenance of uniform temperature inside almost impossible. If insulating lining is used (of either the wool type or the reflective type), the kind of wall construction is relatively unimportant.

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[23] Analogy with the Indian's wigwam must end here as he made no attempt to lower the temperature of his wigwam during warm weather. He did know something about air movement in relation to temperature, however, and controlled this by regulating the flap at the apex of his tepee.

[24] Unfortunately, many industrial buildings are not constructed according to modern methods, and air infiltration is no less than in the Indian's wigwam. Little attempt is made to modify the zero cold of winter or the sweltering heat of summer. As a result, rates of production vary with the season of the year, as shown in Fig. 1–6.

Methods of Heating. The most effective and economical method of heating depends on the nature of the heating problem. Seldom is it either effective or economical to have the heating source located within the space to be heated. The heating furnace is usually located in some remote and less useful space while the heat is transported to the living area by way of water, or steam, or forced air. The heat is provided by the consumption of various fuels such as oil, gas, coal, or wood. The amount of heat is regulated by thermostats located in the heated area and set to maintain a given level of temperature. However, the method of heating is really unimportant so long as it is adequate and controllable by thermostat action.

The Amount of Heat. Here again, the nature of the situation determines the amount of heat advisable for the greatest human efficiency. It would appear from Fig. 1–6 that December and January temperature is better for production in the heavy industries than August temperature. However, so many other factors are involved that such a conclusion may not be justified. Humidity was not constant, and such a variety of work and working conditions was included under the term "output" that the effect of temperature alone is not clear. Mackworth[25] found that errors in hearing and recording Morse code messages by wireless did not begin to increase much until the temperature reached 90°F. His data are shown in Fig. 11–8. On the other hand, the New York State Commission on Ventilation found that an increase in temperature from 68 to 75°F.

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[25] Mackworth, N. H., Effects of Heat on Wireless Telegraphy Operators Hearing and Recording Morse Messages, *Brit. J. Industr. Med.*, 1946, 3, 143–158.

caused a decrease in work (lifting a 5-lb. dumbbell a distance of 30 in.) of approximately 15 per cent.[26] This was true for both fresh and stagnant air conditions. While the amount of work performed was greater in fresh air than in stagnant air, the decrement (15 per cent) was the same when the temperature was raised.

The discrepancy in the temperature at which work decrement begins, illustrated in the two studies just cited, is explained by the difference in type of work. In mental work (like recording wireless messages), the body does not generate as much heat as in physical work (like lifting dumbbells). Body comfort depends on the degree of heat loss or gain, to or from the surroundings, necessary to maintain the normal body temperature of 98.6°F. Generally, it can be said that active physical work can best be performed at temperatures in fifties and the low sixties, while mental work can best be performed in temperatures in the high sixties and throughout the seventies.

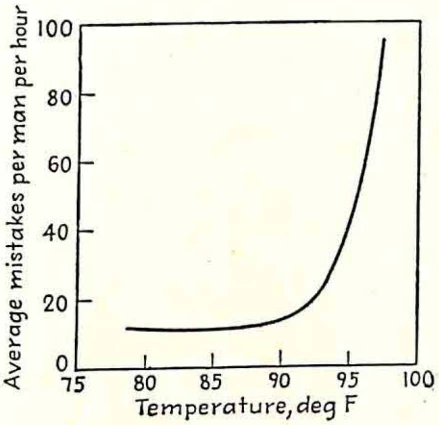

FIG. 11–8. Relation of temperature to errors in hearing and recording wireless messages in Morse code.

Temperature is also significantly related to accident rate in certain industries. Vernon[27] reports an old study of accident frequency and severity among English coal miners in relation to the temperatures in the mines. He found that accident frequency is closely related to temperature, but accident severity does not show such a close relationship. These data are shown in Table 11–10.

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[26] New York State Commission on Ventilation, *Report,* E. P. Dutton & Co., Inc., New York, 1923.

[27] Vernon, H. M., *Accidents and Their Severity,* p. 79, The Macmillan Company, New York, 1936.

TABLE 11–10. ACCIDENTS OF COAL MINERS IN RELATION TO TEMPERATURE

Temperature range	Accident frequency, per million hours	Days lost per 1,000 hours
Coal-face workers:		
Under 70°F.	118	3.9
70 to 79°F.	144	3.7
80°F. and over	178	4.6
Others underground:		
Under 70°F	57	1.8
70 to 74°F.	84	2.4
75°F. and over		

Temperature necessary for comfort is also affected by the amount of radiant heat loss or gain from solid objects in the surroundings. The body can radiate heat to a nearby cold object without affecting the temperature of the air between. On a hot day, an air temperature of 90°F. may not feel warm to a subject sitting beside a cold object. Body heat loss is immediately absorbed by the object. Likewise an air temperature of 55 or 60° may be comfortable if there is *no* cold object or surface in the room. A room lined with effective insulation so that no body heat loss radiates to the cold walls or ceiling will be comfortable at a much lower air temperature than one with surfaces that absorb body heat.[28]

As suggested above, the discussion of temperature *alone* is academic and inconsistent with facts. Comfortable temperature depends on many other factors that are interrelated with it.

HUMIDITY CONTROL

The close relation of humidity to temperature is illustrated in a study by Eichna and his associates.[29] They used acclimatized subjects and then exposed them to varied temperature and varied humidity. Figure 11–9 shows temperatures and humidities that the subjects rated as *easy, difficult,* and *impossible*. Note that a temperature of 105°F. is rated as impossible when the relative humidity is 70 per cent or higher; but when the humidity is 60 per cent or lower, it is rated as easy. Even a relative humidity of 100 per cent does not become impossible until

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[28] Descriptions of experiments in radiation, both for summer cooling and winter heating are given in Mills, C. A., *Climate Makes the Man,* Harper & Brothers, New York, 1942.

[29] Eichna L. W., *et al.,* The Upper Limits of Environmental Heat and Humidity, *J. Industr. Hyg. and Tox.,* 1945, 27, 59–84.

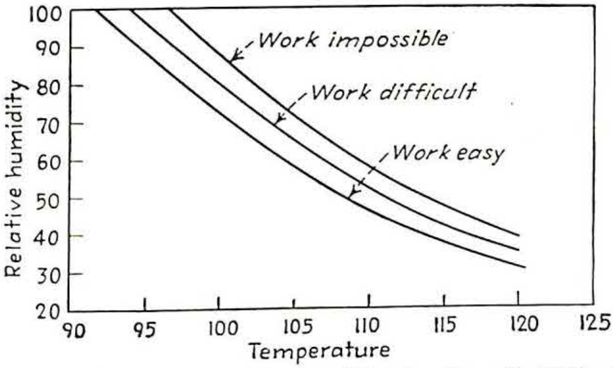

FIG. 11–9. Relation of temperature to humidity for "easy," "difficult," and "impossible" endurance.

the temperature reaches 97°F. In other words, hot weather is more easily endured when the humidity is low. High desert temperatures are endurable because of the extremely low humidity.

The American Society of Heating and Ventilating Engineers has developed a "comfort chart" which shows the interrelation of wet-bulb temperature to dry-bulb temperature to effective temperature. A simplified modification of it is reproduced in Fig. 11–10. It assumes still air, altitude of not more than 1,000 ft., Northern United States locality, and homes and offices where the occupants are adapted to centrally located artificial heating (or cooling) of the convection type. It shows summer and winter comfort zones as determined by the preferences of 50 per cent of those people used in setting up the norms. (This means that approximately 25 per cent preferred higher temperatures and 25 lower temperatures than those shown on the chart.) Note that any specified effective temperature can be obtained by the following combinations: humidity 70 per cent and dry-bulb temperature 73°; humidity 60 per cent and dry-bulb temperature 74°; humidity 50 per cent and dry-bulb temperature 75°; humidity 40° and dry-bulb temperature 76°; or humidity 30 per cent and dry-bulb temperature 77°. At this effective temperature, 1° dry-bulb temperature is about equal to 10 per cent relative humidity.

The use of this chart becomes clearer when the solutions to the following problems are followed.

Problem: A room is to maintain relative humidity at 40 per cent. What dry-bulb temperature will be necessary to give an effective temperature of 72°?

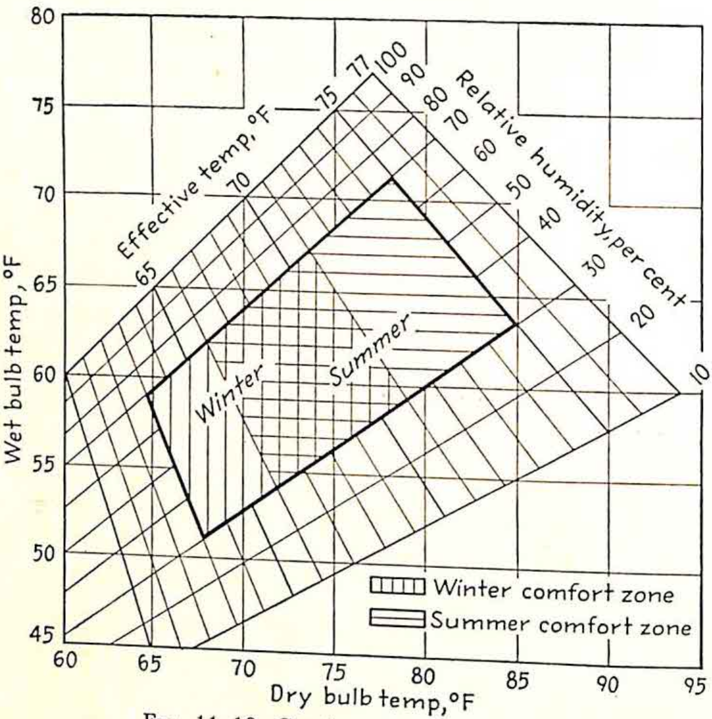

FIG. 11–10. Comfort chart for still air.

Solution: Directly below the intersection of the 72° effective-temperature line and the 40 per cent relative-humidity line (both diagonals), the vertical dry-bulb temperature line intersects the abscissa to indicate a temperature of 77½°F.

Problem: What dry-bulb temperature is necessary to maintain an effective temperature of 65°F. if the relative humidity is held at 60 per cent?

Solution: Follow the 60 per cent humidity line until it intersects the 65° effective temperature line. The point on the abscissa directly below this indicates 67½°F.

Problem: If the dry-bulb temperature of a room is 70°F. and the wet-bulb temperature is 65°F., what is the effective temperature? The relative humidity?

Solution: Follow the 75° dry-bulb temperature vertical line up to the point where it intersects the 65° wet-bulb temperature horizontal line. The diagonal line from here to the upper left will bisect the effective temperature base at 71°, and the diagonal line to the upper right will bisect the relative temperature base at 59 per cent.

It is obvious that humid air can be kept at a given effective temperature with less heat (dry-bulb temperature) than can dry air. It is often cheaper to humidify air than it is to pay for the additional heat necessary to make dry air comfortable, although comfort in both summer and winter demands that humidity be between 30 and 70 per cent. (see Fig. 11–10). Less than 30 per cent humidity causes an uncomfortable feeling of dryness, while more than 70 per cent is experienced as "close" and "sticky."

Feelings of comfort regarding humidity do not change significantly from summer to winter, but they do change regarding both dry-bulb and effective temperature. The effective temperature range of comfort in the winter is between 63 and 71°, while for summer it is between 66 and 75°. The dry-bulb temperature range of comfort in the winter is between 65 and 79°, depending on the relative humidity, and in the summer it is between the limits of 68 and 85° again depending on the humidity.

It is obvious that temperature and humidity are so interrelated that both must be controlled in order to determine any given effective temperature or any given degree of comfort feeling. Modern heating systems in both homes and factories automatically regulate the dry-bulb temperature by thermostat controls and are equipped with humidifiers which can increase the relative humidity to any desired per cent. The important thing is to know how much heat should accompany a given humidity, or how much humidity should accompany a given temperature level. This can be determined from the chart shown in Fig. 11–10.

AIR-MOVEMENT CONTROL

As the British investigators Wyatt, Fraser, and Stock[30] reported many years ago, air circulation increases production under hot humid conditions. They ran fans in a textile plant on alternate working days for 6 weeks during the summer. The fans were then stopped entirely for a week and then run continuously for a week. Production records were kept and periods with fans running were compared with periods with fans stopped. A summary of these results is shown in Fig. 11–11. Note that for every hour of the day, except the hour just before lunch, the production was greater when the fans were running than when they were stopped.

It should be emphasized that inferior production under conditions of noncirculated air is *not* due to oxygen depletion. Noncirculated air is not

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[30] Wyatt, S., Fraser, F. A., and Stock, F. G., Fan Ventilation in a Humid Weaving Shed, *Industr. Fat. Res. Bd. Rept.*, No. 37, London, 1926.

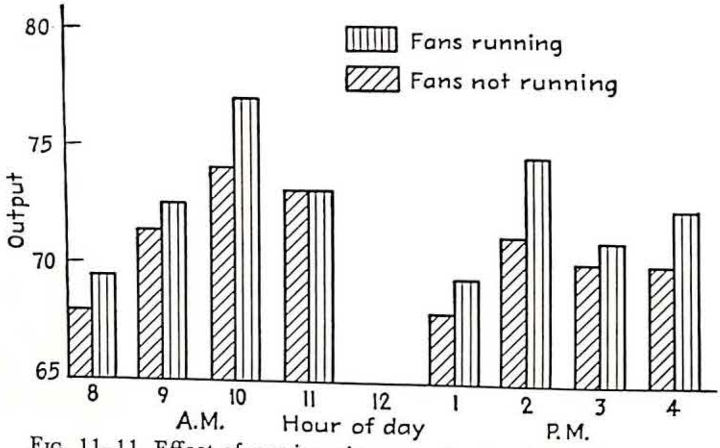

Fig. 11–11. Effect of moving air on production in textile plants.

deficient in oxygen content, nor is there an excess amount of carbon dioxide. It is true that oxygen is slightly reduced but not enough to have any bad effects. The contents of good, poor, and harmful air are given in Table 11–11.

Still air results in reduced production because it slows down the rate of body heat radiation. The body evaporation rate for various rates of air movement in relation to humidity and temperature is shown in Fig. 11–12, taken from a study by Gagge and his associates.[31] These data are for nude bodies. Clothing affects the rate of evaporation, depending on its heat conductivity.[32] At any rate the value of moving air is not the additional oxygen it supplies but the cooling effect it has on the human body by facilitating the radiation of heat. Moving air increases body heat loss.

Table 11–11. Gas Content of Air

Gas	Good air, per cent	Poor air, per cent	Harmful air, per cent
Oxygen	20.93	19.0	14.0
Nitrogen	81.7	81.7	83.6
Carbon dioxide	0.3	0.3	2.4

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[31] Gagge, A. P., Herrington, L. P., and Winslow, C. A., Thermal Interchanges between the Human Body and its Atmospheric Environment, *Amer. J. Hyg.*, 1937, 26, 84–102.

[32] A single layer of herring-bone twill adds a heat load equal to 2 to 4°F. wet-bulb temperature.

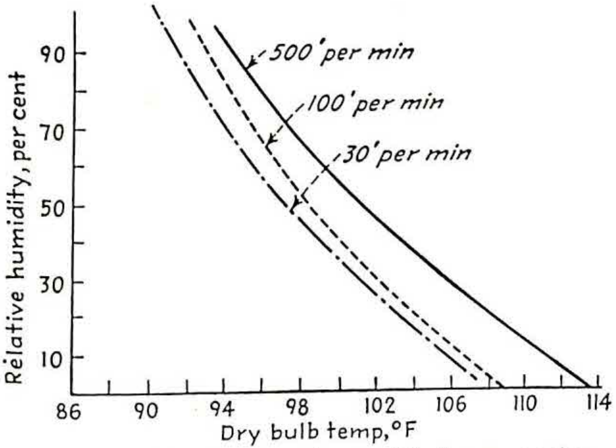

FIG. 11–12. Air velocity and rate of body evaporation.

The interrelation of all three of these factors governing the effectiveness of ventilation is illustrated in Table 11–12. These data were taken under conditions of minimum radiation and with nude subjects. Obviously other temperatures would apply with clothed subjects and under conditions of radiation.

TABLE 11–12. MAXIMUM DRY-BULB TEMPERATURES AT WHICH THE BODY CAN MAINTAIN 98.6°F. IN A RESTING STATE

Relative humidity, per cent	Air movement, per min.	
	17 ft.	500 ft.
0	112°F.	114°F.
50	97°F.	101°F.
100	90°F.	93°F.

When ventilation is inadequate and the body is unable to maintain its thermal homeostasis, there is profuse perspiration and a depletion of the salt content of the body. Sodium chloride is the major electrolytic constituent of most body tissue. There is a normal daily turnover of about one-twentieth of the 8 or 9 oz. of salt in the human body. Excessive perspiration may reduce this to dangerous levels, symptomized by cramps, fatigue, depression, and accelerated heart action. Salt tablets should be provided free of charge and workmen should be encouraged to take them when ventilation conditions do not provide for ready radiation of excess body heat.

SUMMARY

Industrial production is affected by lighting and ventilation to a greater extent than is generally recognized. The typical or average industrial plant is inadequately lighted and inadequately ventilated. Improved lighting and improved ventilation usually increase production values to levels exceeding those of the cost of improvements.

Good lighting depends on three interrelated factors: human seeing ability, light reflection, and the quantity and quality of the light itself. Improved *lighting* requires attention to all three of these factors.

Also, good ventilation depends on three interrelated factors: temperature, relative humidity, and air movement. Improved *ventilation* requires attention to all three of these factors.

The obvious complexity of both lighting and ventilation suggests that they should be fields of specialization. Industrial lighting problems should be solved by the lighting engineer who, as a specialist, is acquainted with the various types of lighting. Likewise, ventilation engineers should solve problems of industrial ventilation. They, too, are acquainted with the most modern ventilation methods and the appropriateness of those methods in specific situations. This chapter has reviewed some of the psychological aspects of these two fields of specialization.

RECOMMENDED READINGS

BARTLEY, S. H., and CHUTE, E.: *Fatigue and Impairment in Men*, Chap. 5, McGraw-Hill Book Company, Inc., New York, 1947.

CHAPANIS, A., GARNER, W. R., and MORGAN, C. T.: *Applied Experimental Psychology*, Chap. 14, John Wiley & Sons, Inc., New York, 1949.

LUCKIESH, M.: *Light, Vision and Seeing*, D. Van Nostrand Company, Inc., New York, 1944.

——— and MOSS, F. K.: *The Science of Seeing*, D. Van Nostrand Company, Inc., New York, 1937.

POFFENBERGER, A. T.: *Principles of Applied Psychology*, Chaps. 8–9, Appleton-Century-Crofts, Inc., New York, 1942.

Chapter 12

AGE OF WORKERS*

- Characteristics Associated with Aging
    - Age Composition of Our Population
    - Sensory Abilities and Age
    - Motor Abilities and Age
    - Mental Abilities and Age
    - Educational Growth and Age
- Age and Industrial Activities
    - Age and Labor Turnover
    - Age and Attitudes
    - Age and Accident Rate
    - Age and Job Performance
    - Age and Job Satisfaction
- Age and Outlook
    - Changes in Needs and Goals with Age
    - Age and Retirement Outlook
    - Time in Retrospection
- Summary

CHARACTERISTICS ASSOCIATED WITH AGING

Age Composition of Our Population. The Industrial Revolution brought with it a rapid expansion in our population as well as a rapid decline in our mortality rate. The effect was to increase the total number, as well as to change the age composition, of our population. Later stages of industrialization have been characterized by the concentration of a large part of our population in cities and by a rapidly declining birth rate. Also, the population of old people has continued to increase. It is estimated that by 1960 those over sixty years of age will constitute one-eighth of our total population in contrast to one-tenth in 1940. According to the Thompson-Whelpton[1] estimates:

> . . . the number of persons 65 and older will increase from 9 million in 1940 to 14 million by 1980. The total population of working age, 20 to 64, is expected to increase from 77 million in 1940 to 90 million in 1960, and a larger proportion of those persons will be at the more advanced ages in 1960 than in 1940. The number of persons 45 to 64 years is expected to increase from 26 million in 1940 to 34 million by 1960, and to 40 million by

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* This chapter was written by Dr. Karl C. Garrison.

[1] Hauser, Philip M., and Taeuber, Conrad, The Changing Population of the United States, *Ann. Amer. Acad. Pol. and Soc. Sci.*, January, 1945, p. 19.

1975. In contrast, the number of persons 20 to 44 years of age is expected to increase only from 51 million in 1940 to 57 million in 1975.

Sensory Abilities and Age. A very important consideration in any working situation is that of lighting. This is discussed in Chap. 11. Figure 12–1 shows that the proportion of people with good vision declines with age. The increase in defective vision from age 10 to 40 is gradual. After the fourth decade of life, the rate of increase becomes more pronounced. Less than 5 per cent of persons over 70 have perfect vision (20/20 in both eyes). The range of light needed for comfortable reading also changes with increased age. The materials presented in Table 12–1 give the percentage of cases comprising different age groups

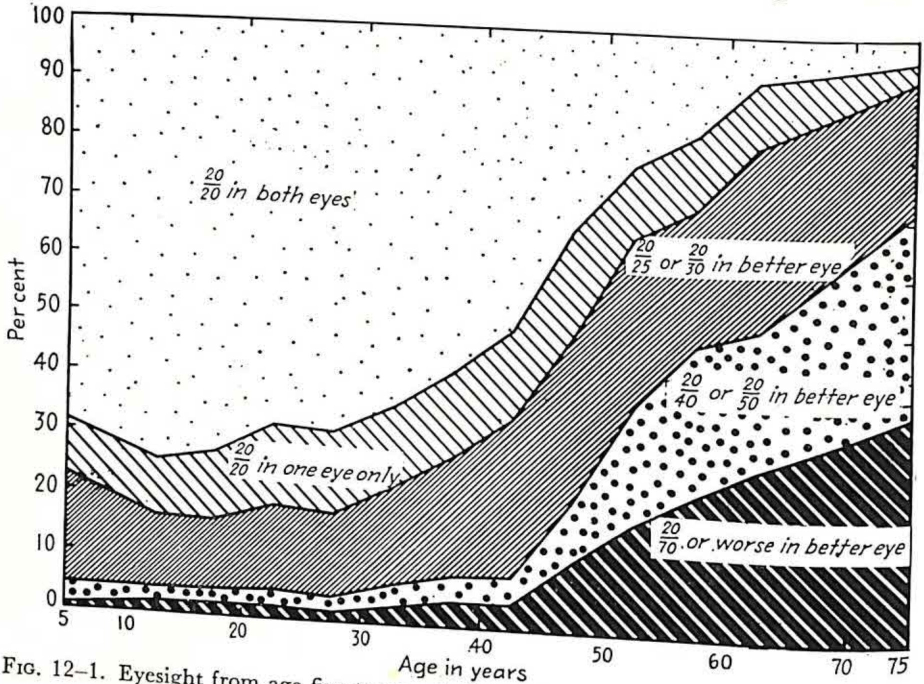

FIG. 12–1. Eyesight from age five to seventy-five. (*Courtesy U.S. Health Department.*)

TABLE 12–1. PERCENTAGE OF CASES IN WHICH CERTAIN FOOT-CANDLES OF LIGHT FALL WITHIN THE RANGE OF COMFORTABLE READING

Group	5 ft.-c.	10 ft.-c.	15 ft.-c.	20 ft.-c.	25 ft.-c.
Total	20	65	55	38	28
10 to 20 years	21	79	57	44	29
Below 35 years	16	78	49	34	24
Above 35 years	24	60	60	41	31

in which certain of the more commonly recommended foot-candles fall within the range for comfortable reading.[2] For the group as a whole, it is sufficient to say that, in general, 10 ft.-c. fall within the range for comfortable reading for the highest percentage of cases, with the exception of the group above the thirty-five-year level. The results from this table indicate that there is a slight tendency for the more advanced age group to prefer lighting of a slightly greater intensity. This tendency is borne out by other studies as well. People in the ten- to twenty-year age group generally prefer more light than those in the twenty- to thirty-year age group. This is probably due to a lower sensitivity to glare during the earlier ages. The ability to perceive a certain number of stimuli per unit of time was used by Brozek and Keys[3] as an index of the efficiency of the visual system. Since this ability does not correlate highly with other visual abilities, it may be regarded as an independent and fundamental characteristic of the visual apparatus. Because of this, it was used by these authors to provide information relative to age changes in physiological functions. Fifty-six women ranging in age from eighteen to sixty were studied in connection with the problem: Does the average flicker-fusion-frequency level change with increasing age? The results showed a small but progressive decrease with increased age in the groups studied (see Fig. 12–2), with the greatest drop beginning with the forty-

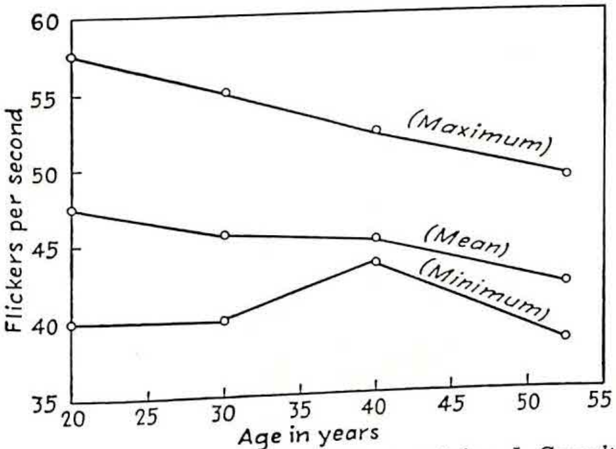

Fig. 12–2. Flicker-fusion-frequency and age. (*By permission, J. Consult. Psychol. and American Psychological Association.*)

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[2] Feree, C. E., and Rand, G., Work and Its Illumination, I, *Person. J.*, 1940, **19**, 62.

[3] Brozek, Josef, and Keys, Ancel, Changes in Flicker-fusion Frequency with Age, *J. Consult. Psychol.*, 1946, 9, 87–90.

four-year age group. However, they added that "alterations in FFF (flicker-fusion-frequency) level associated with 'general fatigue' from the days' work showed no relation with age."

These facts have important bearings on industrial activities requiring keen vision. The results of the flicker-fusion experiment lead to the generalization that the older employees may be able to do inspection tasks under ordinary conditions as well as the younger person. Although the adjustment of his vision to different visual demands is one of his greatest visual handicaps, the older person is able to perform ordinary work tasks, since corrective glasses are available.

Measurable changes in hearing acuity also occur with age. These changes often have their beginnings during childhood or well before maturity. There is, according to studies by Bunch, a progressive loss of keen sensitivity to high pitch (high vibration frequencies). This is shown in Fig. 12–3, where the audiogram at age twenty is used as the basis for the comparison. Thus, after the age of fifty the individual's hearing sensitiveness is confined to a narrow range of less than 1,000 cycles in contrast to that of over 8,000 cycles at maturity. This does not, however, present a serious handicap to the worker since he is usually sensitive to ordinary sounds and ordinary speech, and since modern hearing aids are available.[4]

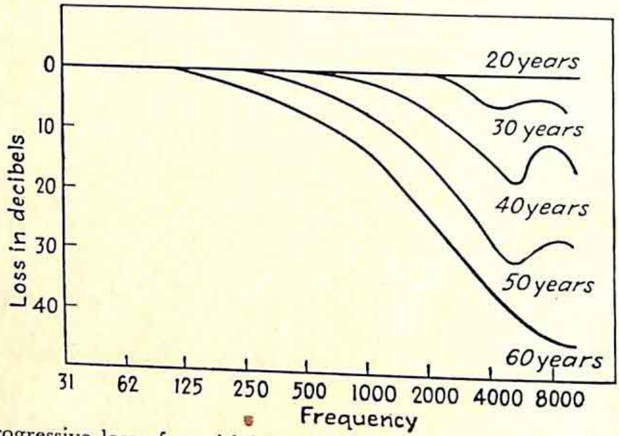

FIG. 12–3. Progressive loss of sensitivity at high frequencies with age. (*After Bunch.*)

Motor Abilities and Age. There has been considerable speculation about the decline of bodily strength during the later part of life. Studies dealing with this problem have not been in agreement concerning the amount of decline appearing at different age levels, although it is generally agreed that a decline begins somewhere in the late twenties or early thirties. Most studies indicate that the rate of decline increases with age. Caution should be observed, however, in making generalizations to individual cases from averages of the different age groups. Data secured on 552 male manual industrial workers by Fisher and Birren[5] on hand strength as measured by the dynamometer showed that the maximum strength appeared in the middle twenties. "At age 60 the decline in average strength amounted to 9.25 kg., or 16.5% from the maximum. There was considerable overlapping among age groups." Such a decline is not sufficient, in itself, to incapacitate the sixty-year-old worker for ordinary work tasks. His maximum strength, however, should be recognized in connection with tasks calling for such strength. Even with these tasks wide differences exist, so that many individuals at sixty have more physical strength than the average person has at his optimum period.

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[4] Bunch, C. C., Age Variations in Auditory Acuity, *Arch. Otol.*, 1929, 9, 625–636. See also Morgan, Clifford, *Physiological Psychology*, pp. 238–239, McGraw-Hill Book Company, Inc., New York, 1943.

A comparative study of the physical abilities of 355 healthy men and women, ages seventy to one hundred years, was conducted by Yoshihido.[6] These individuals were given tests for strength of grip, rate of tapping, dexterity, rote memory of words, and space perception.

TABLE 12–2. STRENGTH OF GRIP IN 5-YEAR AGE INTERVALS

Subjects tested	Age intervals					
	70–74	75–79	80–84	85–89	90–94	95–100
Men, right-handed	29.2	27.2	25.8	23.3	18.0	
Men, left-handed	27.7	25.5	24.3	22.3	18.7	
Women, right-handed	19.4	18.1	16.5	14.4	17.0	10.1
Women, left-handed	17.9	17.3	15.2	17.9	14.3	10.3

Table 12–2 shows the strength of grip for men and women in these advanced age groups. These results indicate that there is a rather steady and marked decline of strength of grip after the age of seventy. Since men have usually attained a higher performance than women in strength of grip, there is a greater decline for men at seventy than for women at

this age level. The decrease in number of taps with age is not as great as that of strength of grip. The decline of scores on the peg board is not as regular as for grip; but the decrease in this ability is more clearly shown than is the case for tapping. The notion, therefore, that the worker is no longer able to perform industrial operations requiring speed of movement or strength after he has reached the fourth or fifth decade is not borne out by this study or by the performance of the older workers during the Second World War.

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[5] Fisher, M. B., and Birren, J. E., Age and Strength, *J. Appl. Psychol.*, 1947, **31**, 490–497. By permission of the *Journal* and the American Psychological Association.

[6] Yoshihido, Kibo, Mental and Physical Changes in Old Age, *J. Genet. Psychol.*, 1938, **53**, 101–108.

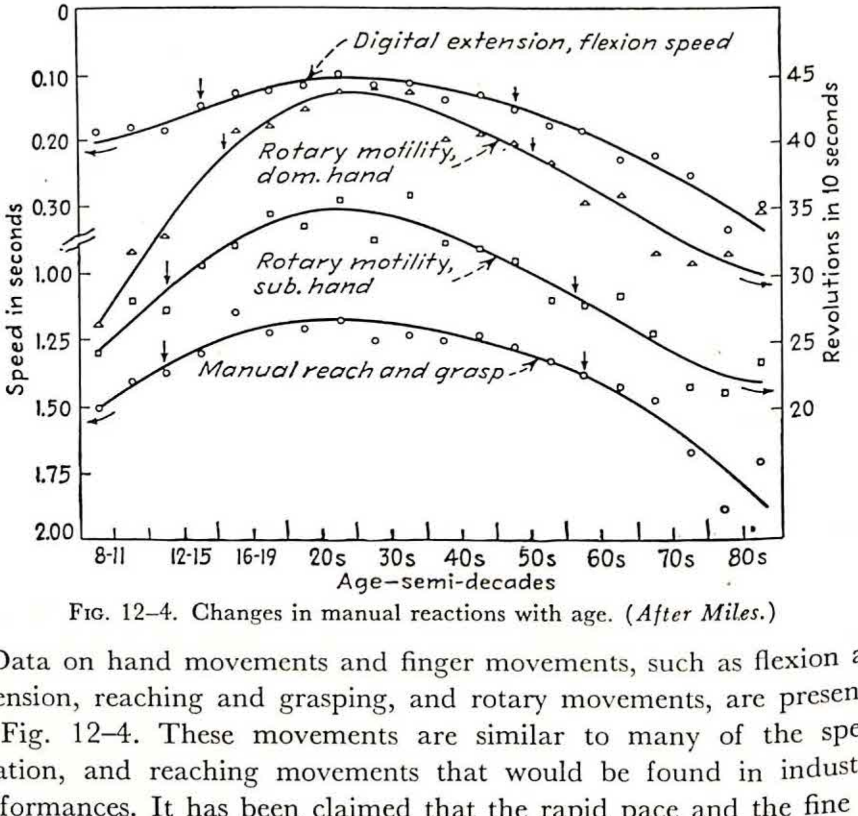

FIG. 12–4. Changes in manual reactions with age. (*After Miles.*)

Data on hand movements and finger movements, such as flexion and extension, reaching and grasping, and rotary movements, are presented in Fig. 12–4. These movements are similar to many of the speed, rotation, and reaching movements that would be found in industrial performances. It has been claimed that the rapid pace and the fine coordinations involved in most industrial operations disqualify the older worker. The materials of Fig. 12–4 show a gradual rise in these manual reactions to a period somewhere in the twenties, followed by a fairly steady decline.

As an additional part of this study, Miles measured the speed of reaction of the hand and feet to an auditory stimulus and also the accuracy of the pursuit reaction of the hand.[7] Pursuit accuracy was found to increase up to age eighteen and remain fairly uniform until around thirty. There is a gradual decline in this ability thereafter. The reaction time for the hand does not show a decline until around the age of sixty, while that for the foot shows an earlier decline. Miles[8] has presented the following conclusions and generalizations from these investigations:

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[7] Miles, W. R., Measures of Certain Human Abilities throughout the Life Span, *Proc. Nat. Acad. Sci.*, 1931, 17, 631.

> The smallness of the decline in reaction speed in middle maturity and the persistance in later maturity and in old age of skill in rotary motility and in reach and grasp, is very striking. Efficiency in the preceding tests depends primarily on speed but we secured evidence also concerning performance in patterns and habits where self-checking and persistence counted and slowness was not penalized. Tests of accuracy in line drawing and quality in handwriting show less decrement with advancing age than does reaction speed. The maintenance may be due largely to the usual adequacy of visual guidance of movement, but I think we need to note the trend shown here for superiority of performance in older people in task where diligence is more important than quickness.

Mental Abilities and Age. The relationship between mental ability and age is important in connection with the performance of employees in business and industry. A study of this relationship, from early childhood to maturity, has provided considerable data on growth. These studies were made, annually, with single groups of children. Such studies are more easily conducted with children than with adults since they can be longitudinal in nature. Children in school can be tested more uniformly. They represent the true cross section of their age groups since the bulk of the child population is in school. The fact that most data on adults consist of cross-sectional data and are not based on the true average must be recognized in the interpretation of such data.[9]

Some of the first extensive data gathered on this problem were collected by Yerkes from scores for soldiers of the First World War on the Army Alpha Test.[10] Comparisons were made between the average scores of the different age groups. These comparisons revealed changes in scores in relation to age level; however, it is certain that the results in this case were affected by selective factors operating at the different age levels, and do not indicate the true amount of change with age. Later studies by Walter R. and Catherine Cox Miles[11] are more extensive in nature and probably represent more nearly similar samplings at the different age levels. An abbreviated form of the Otis Self-administering Tests of Mental Ability was given to 823 persons ranging in age from 7 to 80. These subjects came from two cities, one an industrial and banking city of approximately 12,000 people and the other a residential and banking city of approximately 15,000 people. The results of the tests administered to 617 persons in the second city (City B) are presented in Table 12–3. These scores indicate that mental maturity is reached by the fifteen- to nineteen-year-old group and that it remains relatively constant but with a slight decline up to age fifty. The rate of decline is slightly accelerated at this age; however, there is not a sharp decline until after the age of sixty-five. A caution suggested by the investigators in the interpretation of these data is the fact that this is an abbreviated form of the Otis test and the time limit for taking the test was set at 15 minutes.

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[8] Miles, W. R., Age and Human Ability, *Psychol. Rev.*, 1933, 40, 114. By permission of the *Review* and of the American Psychological Association.

[9] It would not be necessary to have a group representing the true average in order to make comparisons between age groups except for the fact that selective factors affect the intelligence level of those seeking employment in a special concern at a particular period. Also, there are selective factors operating in connection with labor turnover, promotions, etc. One cannot be sure that the selective factors were similar in nature at different periods.

[10] Yerkes, R. M., *Memoirs*, Vol. XV, National Academy of Science, Washington, D.C., 1921.

TABLE 12–3. DISTRIBUTION OF SCORES ON THE SHORT OTIS TEST BY AGE GROUP FOR 617 SUBJECTS OF A TYPICAL AMERICAN CITY

Semidecades	Number of cases	Mean scores	Otis mental age	Sigma
15–19	51	38.50	17·5	8.0
20–24	40	38.10	17·3	7.0
25–29	40	39.22	17·4	8.2
30–34	43	35.26	16·8	10.3
35–39	44	35.06	16·7	8.4
40–44	48	33.82	16·5	11.4
45–49	42	34.50	16·6	11.0
50–54	63	30.98	15·11	11.6
55–59	56	28.74	15·4	9.0
60–64	50	27.94	15·1	11.2
65–69	53	24.22	14·3	9.6
70–74	42	23.78	14·1	10.5
75–79	26	20.46	13·0	8.6
80–84	13	14.50	11·6	9.4
85–89	5	15.30	11·10	9.6
90–94	1	15.50	11·11	0.0

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[11] Miles, C. C., and Miles, W. R., The Correlation of Intelligence Test Scores and Chronological Age from Early to Late Maturity, *Am. J. Psych.*, 1932, 44, 44–78.

This speed factor appears in all studies of this nature to operate as a handicap for the older worker.

A study by Lorge[12] furnishes good evidence that the speed factor is important in connection with scores made by different age groups on mental tests. He gave a battery of intelligence tests to 143 subjects. These subjects ranged in age from twenty to seventy years. Table 12–4 shows the scores of three age groups on the tests of intelligence. The average scores of the three age groups were approximately the same on the CADV test, which is a power vocabulary test. These results furnish good evidence for the generally accepted viewpoint that, when time is not an important factor, there is little deterioration in mental ability with age, prior to senescence.

TABLE 12–4. MEANS FOR A BATTERY OF SIX TESTS OF INTELLECTUAL ABILITY BY THREE DIFFERENT AGE GROUPS EQUATED ON THE BASIS OF ALTITUDE SCORES ON THE CAVD SCALE

Age range	CAVD	Army Alpha	Otis S-A Tests (20 minutes)
20.0–25.0	405.25	149.61	44.39
27.5–37.5	405.66	142.26	39.26
Over 40.0	405.51	132.43	33.39

A recent study of Foulds[13] furnishes information on another aspect of this problem. The Progressive Matrices and the Hill Vocabulary Scale were administered to over 5,000 unskilled and skilled subjects, composed of administrative workers, and technical and university students. The Progressive Matrix Test is designed to measure an individual's capacity to form comparisons between meaningless figures presented and to develop from them a logical method of reasoning from analogy. The vocabulary measures the general fund of verbal information one has acquired. A comparison of the score of the different age groups on the two tests reveals that a person's learning capacity, as measured by the Progressive Matrix test, develops rapidly until around thirteen years of age. Shortly after the age of thirteen it reaches its maximum and maintains this until about the age of thirty, after which there is a slow but steady decline. Foulds[14] concludes:

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[12] Lorge, Irving, The Influence of the Test upon the Nature of the Mental Decline as a Function of Age, *J. Educ. Psychol.*, 1936, 27, 100–110.

[13] Foulds, G. A., Variations in the Intellectual Activities of Adults, *Amer. J. Psychol.*, 1949, 62, 238–246.

[14] *Ibid.*, p. 246.

Except that the rate of development and decline appears to be different at different intellectual levels, the results agree with the findings of other investigators. A person's capacity for intellectual activity appears to have reached its maximum by the age of 14, to remain constant for about 10 years and then to decline. The recall of information appears to increase up to about the age of 30 and remain relatively constant up to the age of 60.

The study by Charlotte Fox[15] is closely related to this. She compared the vocabulary test scores of persons in the decades forty to forty-nine and seventy to seventy-nine age groups. She found no significant differences in the mean scores of the two groups. She also points out that testing should be adapted to the maturity level of the group being tested, and that individual testing furnishes a more accurate estimate of the maximal mental functioning for many of the older aged groups. Wechsler[16] found that some of the subtests of the Wechsler-Bellevue Scale registered a smaller decline with age than did others.

The abilities measured by the General Information and the General Comprehension tests hold up much better with the advanced age groups than those measured by the Memory Span and Digits tests. From a study of the results of the eleven subtests of the scale, he was able to determine those tests which were constant for the various age levels and those which were not constant. The following categories are presented:

Tests Which Are Constant with Age

Information
Comprehension
Object assembly
Picture completion
Vocabulary

Tests Which Are Not Constant with Age

Digit span
Arithmetic
Digit symbol
Block design
Similarities
(Picture arrangement)

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[15] Fox, Charlotte, Vocabulary Ability in Later Maturity, *J. Educ. Psychol.*, 1947, 38, 482–492.

[16] Wechsler, David, *The Measurement of Adult Intelligence*, p. 64, The Williams & Wilkins Company, Baltimore, 1944.

The results of these studies have important implications for personnel workers in industry and business. The handicap of the older worker in his reduced speed of reaction to test items seems to account for his poorer showing in comparison with the younger worker on certain mental tests. If the mental processes involved on the job require speed, the younger worker is at an advantage. The greater fund of experiences of the older worker would be at a disadvantage in certain clerical activities calling for shift of attention, substitutions, and the like. On vocabulary, comprehension, and general information the older worker is not handicapped.

Educational Growth and Age. Evidence has already been presented to the effect that there is no decline in vocabulary ability with age level. There is, however, an apparent slowing up in the speed with which an individual can perform tasks such as those found in mental tests. Also, it appears that the older subject should learn to perform activities in line with habits and skills already acquired rather than to learn new habit patterns and skills. This generalization is important in connection with the shifting of workers from one task to another. It was pointed out earlier that the older worker (under sixty-five) is not significantly handicapped in the performance of most industrial activities; in some cases he might actually be at an advantage. However, if maladjustments are to be avoided and the optimum efficiency ensured, care should be taken that he be placed on jobs related to skills already established. When this is done, his record for accidents, production efficiency, and morale will likely be above rather than below average.

Positive evidence has been presented by Lt. Col. Harry C. Eckhoff, Chief of the Airman Information and Education Branch, Personnel Services Division of the U.S. Air Force,[17] that adults of thirty-five are better educated than younger adults, despite fewer years of schooling on the part of the older adults. The results of 6,000 military examinees who had taken the General Educational Development Tests were studied by Colonel Eckhoff. He found that the average standard score increased with age level from age fifteen to beyond the age of thirty-five (the age range of subjects taking the tests). Colonel Eckhoff concludes that "greater interest and effort, improved sense of judgment and values, ability to interpret and to think critically by using one's own experiences, ideas and information probably all combine to give the older examinee a distinct and unique advantage over his younger fellow examinee."

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[17] Education Level Rises with Age, *Adult Educ. J.*, 1949, 8, 191.

AGE AND INDUSTRIAL ACTIVITIES

Age and Labor Turnover. Workers change jobs for many reasons. Among younger workers there is usually a constant turnover, which may be largely accounted for by (1) the trial-and-error job seeking procedures, (2) lack of family responsibilies, (3) an immediate felt need for a larger income, and (4) opportunities for growth and development which appear on other jobs.

Family as well as other financial responsibilities will tend to reduce labor turnover. Since family responsibilities are likely to increase for most workers in the middle or upper twenties, there is a decreased labor turnover among groups of workers falling into this age group. However, the element of supply and demand is always important. There is often a great demand for individuals (particularly white collar workers) in the twenty-five- to forty-year age group. Thus, one should not generalize too widely from data on labor turnover in one type of work to that in another type of work.

The morale survey reported by Benge and Campbell[18] furnishes information concerning age and morale. This survey was conducted by the management of a confectionery company with a total of 772 workers in five small plants. In comparing morale and age, the authors reported that "employees under 20 years of age have high morale while those between 20 and 29 years of age have low morale. After this minimum, morale rises again with each successive age grouping." This is in harmony with findings relative to labor turnover. After workers pass the middle forties, there is a decided decline in the rate of turnover. Security, few opportunities for employment, close-knit ties within the industry and neighborhood established through the years, and other factors connected with his home, neighborhood, and working life lead to an increase in job stability at this age.

Age and Attitudes. The attitude of young workers toward various phases of their work was studied by Tenen.[19] Over 90 per cent of the young workers in two clothing factories were interviewed. It was found that the majority of these young workers has been eager to leave school and to secure employment; however, they had received little guidance in connection with securing employment or in determining the type of work which they should enter. There was a general expression of dissatisfaction toward their work and the work authority. The average number of complaints appeared to increase with age. There was a general feeling expressed by both sexes that work authority cared little for their general welfare—not even with respect to the acquisition of new skills and thus to the improvement of their working lot. They expressed concern over their working conditions, general health and physical conditions, security of social status, and the opportunity for learning new skills.

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[18] Benge, E. J., and Campbell, D. F., Employee Morale Survey, *Mod. Mgmt.*, 1947, **12**, 19–22.

[19] Tenen, C., The Adolescent in the Factory, *Brit. J. Educ. Psychol.*, 1947, **19**, Part 2, 72–82.

During the depression year 1934, data were secured on 538 persons who had sought the services of the Adjustment Service in New York City. These individuals ranged in age from the late teens to more than sixty, while their educational status varied from the elementary grades to postgraduate study. The Hall Scale for Occupational Morale was given to this group. Watson points out from this study that " . . . there is no significant relationship between morale and age over most of the range, but the men over 45 years of age, on the other hand, did have a morale score higher than that of the rest of the population." The more mature individuals of this study maintained their faith in the American system and the opportunities it afforded to a higher degree than did the younger people. This is to be expected on the basis of the ease with which young people take up new ideas and become dynamic advocates for then. In connection with this, it might be stated that proposals for changes would find their greatest support among the young people.

According to the findings of the Fortune Survey (see Table 12–5), the American dream of improvement and promotion seems for many a myth. Farm proprietors show the same opinion as the factory workers and the union members. A further analysis shows youth to be over-

TABLE 12–5

Question: Do you think the years ahead seem to hold for you personally a good chance for advancement, or the probability of little real improvement over your present position?

Answer	Total, per cent	Professional and executives, per cent	Salaried employees, per cent	Factory workers, per cent	Union members, per cent
A good chance for advancement	53.3	63.4	60.7	47.7	48.7
Little real improvement	33.4	31.1	31.9	40.7	41.2
Don't know	13.3	5.5	7.4	11.6	10.1

whelmingly optimistic, while those over forty do not expect any improvement, during their remaining years, over the present.[20] This is closely related to morale. The morale of the young worker may be expected to be low, when he feels that there is little opportunity for advancement. The older worker, being more realistic, is more inclined to accept conditions without being too disturbed by the future.

Age and Accident Rate. Although no generalizations can be made which would be applicable to all activities, there is in general a decline in accident rate with increased age. This may be attributed to a number of factors, including (1) increased skill resulting from the added experience, (2) increased caution or conservatism which develops with age, (3) transfer of the worker to less hazardous tasks as he grows older, (4) increased sense of responsibility which affects the work habits of the individual, and (5) possible errors which result from cross-sectional data on rate of accidents.[21] Because increased age is associated with greater susceptibility to fatigue and higher temperature, one would expect the accident rate to increase when the work is strenuous and when the temperature is high.[22] The accident rate, according to Vernon is lowest for coal-face workers in the thirty- to thirty-nine-year age group and for underground workers in the twenty- to twenty-nine-year age group. However, in the transportation industry, there is a decline in the accident rate with increased age; thus, the average individual of sixty-five is not to be regarded as an accident hazard. The high accident rate among young men in all activities is probably a result of factors diametrically opposed to those which preclude a low accident rate with increased age. Their lack of experience, their irresponsible nature, their impulsiveness, and their daring characteristics are qualities which make them accident prone. (Accident rates have already been discussed in Chap. 9.)

Age and Job Performance. The problem of the relationship between age and ability in adults, accentuated by an unfavorable attitude often displayed by industry toward men over forty years of age, is an important one in conection with our present industrial problems. Studies cited earlier in the chapter indicate that there is a rapid rise in speed of reaction, strength, and motor coordination during childhood and adolescence. These motor abilities reach their maximum between the ages of eighteen and thirty, after which there is a slow decline, accelerated after the age of sixty-five or seventy.

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[20] Reprinted from *Fortune* magazine, January, 1947, 35, 5–6, 10, 12. Copyright Time, Inc.

[21] See Newbold, E. M., A Contribution to the Study of the Human Factor in the Causation of Accidents, *Industr. Fat. Res. Bd. Rept.*, No. 34, London, 1926, 74, p. 28.

[22] Vernon, H. M., *Accidents and Their Prevention*, p. 57, Cambridge University Press, London, 1936.

The studies cited are based upon tests of motor ability conducted in a laboratory situation and measured by short test trials. The purpose of a study by Kinsley Smith[23] was to investigate the differences accompanying age in performances more closely analogous to an industrial work situation. Short tests give little evidence of the ability of a subject to maintain his level of performance over a period of time comparable to the industrial work period. This seems to be a significant point, since a common belief that older men have lower endurance is one of the major barriers to their gaining employment. Furthermore, short trial periods give little indication of differences which may exist among the various age groups with respect to speed in warming up to the work, or to the variation in work pace from time to time during the work period.

The study by Smith, in addition to attempting to meet these objections, affords a comparison of age differences with respect to output as determined by a short test period and by a long work period at the same performance. One hundred and fifty-five men, who were considered physically fit and capable of profiting from industrial training, were used as subjects for this study. They were in the twenty-, thirty-, forty-, and fifty-year age groups and were roughly matched for intelligence. The motor performance consisted in assembling and disassembling the same two nuts and bolts over a period of time. The subjects worked for two periods at this assembly task. The first was a 15-minute period, while the second was 4 hours long. A financial incentive system in the form of a straight piece-rate plan was applied and seemed to furnish adequate motivation. Thus, the task was quite similar in many ways with many routine factory operations.

The average scores of the different age groups for the short assembly period are presented in Table 12-6.[24] These data reveal that performance improves slightly from age twenty to age thirty, dropping at age forty, and decreasing further at the 50-year age level. In general, the long period of work showed the same trend as the short period; however, the

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[23] Smith, Kinsley R., Age and Performance on a Repetitive Manual Task, *J. Appl. Psychol.*, 1938, 22, 295–306.

[24] Adapted from *Ibid.*

TABLE 12–6. AVERAGE PRODUCTION OF THE FOUR AGE GROUPS FOR THE SHORT ASSEMBLY PERIOD

Group	Average production	Distribution	Per cent of production of age-group 30
20	34.39	4.56	97.0
30	35.44	5.60	100.0
40	33.90	4.54	95.7
50	32.56	4.98	91.9

differences in the age groups increased in the long period as compared to those for the short period.

An average inferiority of 13.5 per cent in output at a motor performance during a 4-hour period, as demonstrated in this study, on the part of the fifty-year-old men as compared with the thirty-year-old men, would appear to be a serious factor in relation to modern industrial standards. The distribution range indicates, however, that over 17 per cent of the fifty-year-old men score within two points of the median of the thirty-year-old group or above the median. The fifty-year-old group showed no tendency toward relative slowness in warming up to the work at the outset of the long work period. The cause of the gradual decline in performance with age is not wholly clear. Thorndike *et al.*,[25] pointed out a number of years ago that such factors as disuse, interference of well-established habits, and lowered motivation affect the nature of the learning curve. Whatever may be the factors underlying the decline, the handicap of age is not as serious as may have been indicated. Thorndike has suggested the possibility of re-educating the worker, when the need arises, so that he will be able to perform the new tasks demanded by changes in machinery, etc. There is much evidence that older workers can learn to perform tasks somewhat in harmony with skills acquired earlier. Such an educational program would contribute to good morale, reduce labor turnover, and provide for a continuation of the services of a steady, industrious, and reliable worker, who would otherwise be lost to industry. Some industries have already moved in this direction by setting up special shops for the older workers, while others have provided for these readjustments through educational programs.

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[25] Thorndike, E. L., *et al.*, *Adult Learning*, p. 180, The Macmillan Company, New York, 1932.

Age and Job Satisfaction. The problem of job dissatisfaction will receive special consideration in Chaps. 13 and 14. The individual's satisfaction on the job is related to the *total self* and cannot be explained on the basis of any single factor. However, the element of age is important, since it is directly related to experience, seniority, welfare activities, etc. Since the attitudes of the workers are important determiners of the morale of a concern, their satisfaction or dissatisfaction is of utmost importance in relation to production, efficiency, and industrial relations.

Hoppock found a correlation of .21 ± .04 between age and satisfaction of 286 individuals employed in New Hope, Pennsylvania, a typical manufacturing village. Three hypotheses are presented as an explanation for this.[26] The first one is based on labor turnover. With high labor turnover, it appears likely that a large proportion of dissatisfied workers would secure employment elsewhere, or perhaps quit with the hope of obtaining employment elsewhere.

The second is a disillusioned worker's frame of mind. Hoppock states:

> Disillusionment, leading the worker to accept with resignation what he comes to regard as the unfavorable reality of life, may likewise account for a decrease in active dissatisfaction and for an increasing proportion who would rate themselves as indifferent. Some workers appear complacently to accept conditions that to most of us seem intolerable.

The third hypothesis suggested is based upon the growing proficiency and adjustment of the workers. With years of service on the job, the worker comes to learn all the specific factors involved on the job. He adjusts to the peculiar features of his job and to the people with whom he associates. The growing conservatism of increased age is perhaps related to this hypothesis.

AGE AND OUTLOOK

Changes in Needs and Goals with Age. New needs or a change in existing needs may arise as a result of a variety of circumstances. During growth and development, new needs are constantly appearing in the life of a child, while certain childhood needs related to cares and protection disappear or lose their potency. With advancing age some needs appear gradually to fade out, while others seem to become more prominent. Concerning these, Kurt Lewin[27] has stated:

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[26] Hoppock, Robert, Age and Job Satisfaction, *Psychol. Monogr.*, 1936, **47**, No. 212, 115–118. Reprinted by permission of the *Journal* and of the American Psychological Association.

> Generally speaking, needs may be changed by changes in any part of the psychological environment, by changes of the inner-personal regions, by changes on the reality level as well as on the irreality level (for instance, by a change in hope), and by changes in the cognitive structure of the psychological future and of the psychological past. This is well in line with the fact that the total life space of a person has to be considered as one connected field.

The needs of the older workers are not identical with those of the younger workers. After the age of forty, the spirit of adventure has lost its potency and is replaced by more conservative attitudes and a more stable pattern of living. However, decreased family responsibility may have effects upon the stability and upon labor turnover among this group. Rewards for meritorious service, and the like, means much more to the older worker than to the younger, while promotion plans, savings plans, and retirement provisions based upon years of service are probably the most important incentives among younger workers.

Age and Retirement Outlook. The Fortune Survey showed differences in the attitudes of different age groups toward retirement.

> Workers who are forty and over are less confident than the younger; only 39 per cent of those over forty, compared to 45 per cent of those under that age, feel that sixty-five will bring a reasonably comfortable retirement. Forty-five per cent of nonunion workers and a like per cent of independent union workers look forward complacently to sixty-five, compared to 45 per cent of AF of L members and 35 per cent of those affiliated with the CIO.[28]

A study by Elon Moore[29] was concerned with the adjustments of 47 retirants. These individuals were graded on the basis of degree of satisfaction with retirement as follows: excellently adjusted, satisfied, uncertain, dissatisfied. A comparison of those graded at the two extremes—excellently adjusted and dissatisfied—showed the excellently adjusted to have planned their retirements, to have retired voluntarily, to be better off financially, and to have better satisfied wives. The size of the family, presence of grandchildren, and location after retirement were not important factors with respect to adjustment; however, activity appeared to be a significant factor in contributing to good adjustment.

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[27] Lewin, Kurt, Behavior and Development as a Function of the Total Situation, reprinted by permission from *Manual of Child Psychology*, edited by L. Carmichael, published by John Wiley & Sons, Inc., New York, 1946, p. 824.

[28] Reprinted from *Fortune magazine*, May, 1948, p. 12. Copyright Time, Inc.

[29] Moore, Elon H., Industrial Workers Retirement, *Soc. Sci. Res. Quart.*, 1948, 32, 691–696.

Time in Retrospection. A change in life outlook as a whole in a direction opposite to that of development has been referred to as regression. This may be common among many older workers. It is a well-known fact that time perception is vastly different for the older worker than for the younger worker. Most of life's activities for the older worker are in the past. The nature and velocity of satiation of different conditions and incentives will vary with age. The life of the well-adjusted aged individual is dominated by the experiences of the present. Sometimes he resorts to much retrospection, and this often produces a feeling of regret accompanied by despondency. It is for this reason in particular that hobbies and recreational interests are important for older people. In an address before the National Recreation Congress, Menninger[30] stated:

> Recreation is an extremely important aid to growing older gracefully. People who stay young, despite their years, do so because of an active interest that provides satisfaction through participation. The elderly person with a hobby is almost always an alert, interesting person. . . . By contrast, there is no more pathetic sight than the older person who has no interest in life and only sits and waits . . . vivid evidence of the value of recreation to mental health.

SUMMARY

Studies show that, after the age of forty, there is a significant decline in the average sensory and motor capacities of groups of workers. There is also evidence of a decline in intelligence with age, especially when measured by tests in which the speed element is important. These data are based upon averages for various age groups, and it has been suggested that caution be observed in generalizing from averages to individual cases.

Advancing age is accompanied by a changed attitude toward the job as well as toward one's own future. The constantly increasing life span has resulted in a pronounced change in the age ratio of our population. More workers are, thus, found in the upper age bracket. Some concerns attach considerable significance to age. However, evidence does not warrant the instituting of policies which discriminate against the older worker. Business and industry must take into consideration the capacities, needs, and motives of workers of different age groups and institute policies and practices in harmony with these.

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[30] Menninger, William, Recreation and Mental Health, *Recreation*, 1948, 42, 340–346.

RECOMMENDED READINGS

BARKER, R. G.: The Relation of Age of Human Adults to Some Aspects of the Ability to Do Fatiguing Muscular Work. Age range: twenty-five to ninety years, *Psychol. Bull.*, 1934, 31, 606–607.

HALSEY, G. D.: *Handbook of Personnel Management*, Harper & Brothers, New York, 1947.

LAWTON, GEORGE: Old Age Minus and Plus, *Aging Susceptibility*, Columbia University Press, New York, 1946.

NEURCHULTZ, L.. *Jobs for the Physically Handicapped*, Bernard Ackerman, New York, 1944.

POFFENBERGER, A. T.: *Principles of Applied Psychology*, Chap. 3, Appleton-Century-Crofts, Inc., New York, 1942.

POLLOCK, OTTO: *Social Adjustments in Old Age: A Research Planning Report*, Social Science Research Council, New York, 1948.

TAYLOR, F. W.: *Scientific Management*, (Reissue), Harper & Brothers, New York, 1947.

THORNDIKE, E. L.: *Adult Learning*, The Macmillan Company, New York, 1928.

TOOTLE, H. K.: *Employees are People*, McGraw-Hill Book Company, Inc., New York, 1947.

VISCHER, A. L.: *Old Age: Its Compensations and Rewards*. The Macmillan Company, New York, 1948. (Translation by Bernard Miall of the second edition of *Das Alter Schichsal und Erfullung*, 1945.)

Chapter 13

THE WORKER'S MORALE*

- Introduction
  - Importance of Morale
  - Attitude of Worker toward His Job
  - The Changing Concept of Worker Morale
- Evaluating Employee Morale
  - Methods of Determining Morale
    - The Questionnaire
    - The Employee Interview
    - The Employee Counselor
    - Morale Tests and Scales
      - The Tear Ballot for Industry: General Opinion
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  - Fundamental Needs of Workers
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- Methods of Building Morale in Industry
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  - Through Effective Communication
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    - Providing a Favorable Social Environment
- Summary

INTRODUCTION

IMPORTANCE OF MORALE

The zeal of wholehearted and single-minded activity makes the difference between an organization that merely operates and one that cooperates. That quality, that attitude and spirit which provides unity of purpose, has been referred to as "morale." In this day of vast industrial empires, division of labor, labor organizations, absentee ownerships, and impersonal relationships between workers and management, employee morale is becoming recognized as one of the prime determiners of the success or failure of a business enterprise. The importance of morale was certainly recognized in time of war. That its value in peacetime industrial operations is just as significant is shown in this statement by A. L. Kress:[1]

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* This chapter was written by Dr. Karl C. Garrison.

> When we talk about morale, and we have these problems in peacetime just as well as in wartime, we are dealing here with the way people think, the way they regard their jobs, their supervisor, the company, its working conditions, wants—everything that goes to make up the background of the individual's place in the organization scheme.

ATTITUDE OF WORKER TOWARD HIS JOB

The attitude the worker takes toward his job is the result of many factors and conditions. His early experiences and training are important. Due to his early sociocultural environment, he has developed anxieties, or in many cases has failed to develop anxieties, which affect his attitudes toward certain types of work. Some of these problems are discussed elsewhere in connection with job satisfaction and dissatisfaction. Also, home conditions, health, friends, and other factors outside of and beyond the work environment affect the worker's attitude toward his job.

It has been suggested that presentday industrial tasks do not present sufficient challenge to workers and that this becomes a basic cause of much of their dissatisfaction. There is evidence that this factor, per se, is not too important. The responses of workers to the questions listed in Tables 13–1 and 13–2 indicate that most of them do not seek jobs that offer a real challenge.[2]

In connection with a question about the speed of the work, several noticeable group differences were observed. Women seemed to feel the pace more than men. Union members expressed the feeling that they were being pushed to a greater degree than did the nonunion members.

On the surface, Tables 13–1 and 13–2 indicate that workers are well-satisfied with their jobs and find them interesting. Even work on the assembly line was listed as interesting most of the time by 42 per cent

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[1] Kress, A. L., A Sound Compensation Structure—The Foundation of Morale, in National Industrial Conference Board, Morale Factors in Production, *Studies in Personnel Policy*, No. 54, New York, 1943.

[2] Reprinted from *Fortune* magazine, May, 1947, pp. 5–6. Copyright Time, Inc.

TABLE 13–1. SOME SIGNIFICANT ATTITUDES OF WORKERS TOWARD THEIR JOBS

Question	Answer		
	Yes, %	No, %	No opinion, %
Is your job too simple to bring out your best abilities, or not?	25	63	12
Can you do the work on the job and keep your mind on other things most of the time, or not?	41	55	4
Does your job make you work too fast most of the time, or not?	23	74	3
Does your job leave you too tired at the end of the day, or not?	29	67	4
Is your job really essential to the success of the company, or not	88	6	6

TABLE 13–2

Question: Which one of these statements comes closest to describing how you feel about your present job?

Answer	Total, per cent	Non union, per cent	Independent union, per cent	AF of L, per cent	CIO, per cent
My job is interesting nearly all the time	43	48	50	47	35
While my job is interesting most of the time, there are some dull stretches now and then	34	36	28	35	35
Total	77	84	78	82	70
There are a few times when my job is interesting but most of it is pretty dull and monotonous	14	11	14	12	18
My job is completely dull and monotonous; there is nothing interesting about it	6	4	3	5	10
Total	20	15	17	17	28
Express no opinion	3	1	5	1	2

of those thus employed. Further questions revealed that half these workers were frustrated because their work provided them with little or no opportunities for initiative or creativeness. However, there is reason to believe that this may not be the basic source of such frustrations. Case studies show that when workers are made to feel that they are important and that the company appreciates their efforts and loyalty, repetitive work is not necessarily unpleasant in nature. Good working conditions, a democratic atmosphere, a spirit of interest and understanding on the part of management, and an acceptable living standard, with a reasonable degree of security, are factors with which the worker is especially concerned.

The Changing Concept of Worker Morale

The development of large industrial organizations has had its effects upon the attitudes, aspirations, and loyalties of individual workers. Furthermore, developments in psychology have led to a better understanding of human dynamics. It is becoming increasingly recognized that the worker's attitudes and behavior are influenced by conditions off the job as well as those on the job. Also, the general health and happiness of the individual has a definite bearing on his attitude and behavior in all areas of his life.

The close relation that existed between management and labor in the early days of industry in America has for the most part given way to impersonal relations. Grievances, in the early days, related to specific items on the job which were discernible by worker and management. Today, grievances arise as a result of policies, practices, plans, and suspicions that are not always clearly understood by the workers themselves. Morale is no longer a simple grievance against the boss or about the weeks wages but runs deeper than this and is manifested in subtle ways. This has made it far more contagious in nature, so that a few malicious or ill-informed workers may have a deleterious effect on the morale of the entire group. These changed concepts of the nature of morale and the forces affecting it have led to developments in the general area of human relations which will be discussed later in this chapter.

EVALUATING EMPLOYEE MORALE

A sound program for the improvement of morale among a group of workers must be based upon an evaluation of the existing morale and upon a determination of the factors affecting morale. The measurement and determination of employee morale is an extremely complex one. The many factors affecting one's attitude toward his job, the variables operating in his off-the-job activities, and the unstable nature of the individual himself all make the measurement of morale a precarious and difficult problem.

METHODS OF DETERMINING MORALE

A number of different approaches are available for the study of morale. Many of the methods presented here are not new, but have been used to some extent for many years.

The Questionnaire. The questionnaire is frequently used as a means of surveying the morale of employees. It may be administered on company time by a company official or by an independent agency. It may be passed out to the employees for them to complete during their leisure time and return by mail to the company office. The advantages of the voluntary questionnaire method are (1) time, since the employees are not hurried and may give more detailed thought to answers; and (2) an increased feeling of anonymity. Its disadvantages are: (1) a low percentage of returns; (2) organized responses promoted by the potential time lag, since employees may discuss questions; and (3) the possibility that the returns which do come in may not constitute a representative sampling of the employees.

The Employee Interview. The employee interview is another method of ascertaining the nature of the morale of the worker. Since the time factor does not permit the securing of information from a large percentage of the employees, the problem of obtaining a sound cross sampling appears. There are, however, some distinct advantages in the interview procedure. The meeting may be informal in nature. It may uncover unsuspected sources of poor morale.

A serious handicap to the successful use of the interview technique is that the workers are fearful about revealing their true convictions. They are, however, generally more willing to reveal their true feeling and attitudes if they decide to quit their jobs. The exit interview, therefore, becomes an excellent means of determining conditions and policies that irritate workers, and it has many times led to changes within the company to the extent that resigning workers have decided to remain.

Rapport is most important if the industrial interview is to get at the basis of difficulties. First, the individual conducting the interview must have the confidence of the worker. Second, the approach should be friendly in manner and, through an indirect approach, should seek a solution to the particular problem with which the management is concerned. It is often customary to question the employee about both the desirable and the disturbing features of his job, and at the same time to keep the entire discussion on an impersonal level. The aim is to allay any fear of the worker about revealing his true feelings about specific policies and working conditions which directly affect him.

Much has been said in recent years about the nondirective technique in counseling. The worker is encouraged to talk freely about his work or about any problem with which he is concerned. A skilled interviewer will be able to determine those conditions which are satisfactory and those which are not by the willingness or the reticence of the worker to discuss them. Often the inflection of his voice and that which is left unsaid become important clues to his feeling.

The Employee Counselor. The employee counselor is usually a trained counselor employed by the company to advise with employees on their problems. The counselors are often members of the personnel department. Those who are able to gain the confidence of the workers are able to obtain excellent firsthand indications of good or poor morale. The main difficulties faced by counselors are that (1) their information must be kept on a confidential basis, and (2) they are frequently looked upon with suspicion and resentment by supervisors and administrators who have difficulty understanding such employee-management relationships.

Morale Tests and Scales. The use of test and scales as a basis for evaluating morale avoids many of the errors and problems present in the preceding methods. In selecting a method for evaluating morale, the following factors should be considered:

1. Is the method valid? That is, does it measure that for which it is designed?
2. Is the method reliable?
3. Is the procedure of such a nature that the administration of it will enhance rather than hamper good morale?
4. Is the diagnosis sufficiently specific as to furnish a diagnostic basis for determining policies and practices which will aid in the improvement of morale?
5. Is the procedure harmonious with good ethical practices?

In the fall of 1938, a thorough and comprehensive study of morale was undertaken under the direction of Walter Woods of Syracuse University.[3] The purpose of this study was to provide a better understanding of low morale in business and industry, as evidenced by high labor turnover and mass job dissatisfaction. The study continued for 4 years, various phases of the problem being examined exhaustively during that period. The care with which this study was conducted and the nature of the results make it sufficiently important for a fuller description here.

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[3] Woods, Walter A., Employee Attitudes and Their Relation to Morale, *J. Appl. Psychol.*, 1944, 28, 285–301.

As a first step in planning this study, morale was defined as "the liking or disliking, in some degree, the various situations that arise in the process of working with others."[4] It was assumed that the degree of morale would be indicated by the workers' attitudes expressed in terms of likes or dislikes for various factors of their jobs. It was found from this study that working conditions and wages are not necessarily the basic factors which determine morale—a point suggested earlier in the chapter. Furthermore, it was concluded that the definition given for morale was inadequate. Rather, morale was finally defined thus: "Morale is a term that is used to describe special effort or willingness to make extreme effort or sacrifice for the purpose of securing some special value or fact."[5] As a result of information secured during the progress of the study, it became apparent that a study of morale should begin, not with attitudes toward work or a job, but with attitudes toward social values.

The first step in the actual morale measurement process was the construction of a scale. The general Thurstone technique of just noticeable differences was followed. A large number of unselected statements were obtained from many employees, representing varying degrees of attitude toward all phases of typical jobs. These statements were edited and arranged into groups relating to different phases of the work situation, such as wages, supervision, etc. A preliminary scale of 427 statements covering 53 different groups was devised.

The next step was an attempt to determine the reliability of the preliminary scale. It was submitted to a group of 200 raters, each with instructions to rate, on a 0 to 10 basis, the degree of morale which he believed was represented by each statement. All the raters were persons involved in supervisory work of some nature. Once rated, the statements were analyzed statistically on a percentile graph to determine scale position and ambiguity. Statements which did not have a clear meaning and groups which did not show a fairly wide range of opinion were discarded. The completed scale consisted of 134 items divided into the following job segments:

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[4] *Ibid.*, p. 285. By permission of the *Journal* and of the American Psychological Association.

[5] *Ibid.*, p. 300.

Instruction
Responsibilities
Suggestions
Supervisors
Plans
Nature of work
Favors
Courtesy
Public relations
Interests
Advancement
Career
Pay and ability
Working conditions
Recognition
Promotion
Outside influences

The Tear Ballot for Industry: General Opinion. The Tear Ballot for Industry, developed for the purpose of securing a measure of job satisfaction or morale, is an outgrowth of earlier studies conducted by Kerr dealing with the attitudes of workers toward certain aspects of their work.[6] The test is so designed that the employee is quite sure his identity will remain anonymous. Furthermore, the average employee can check all exercises within a period of 2 or 3 minutes. The test, consisting of 10 questions and one problem, includes five possible answers for each of the questions, with the individual checking one from each of the groups of five. The nature of these questions, along with the correlations between tenure rate and job satisfaction as indicated by the response to the questions, are presented in Table 13–3.[7] The materials for this table were obtained from administering the test to 98 wage earners distributed by industries as follows:

agriculture 1, building and construction 11, distributing and selling 22, education and research 5, finance and banking 1, forestry and fishing 1, government 5, manufacturing 24, mining and minerals 2, printing and publishing 2, recreation 1, service occupations 5, telephone and telegraph 7, transportation 9.

The job-tenure rate was used as an independent criterion against which to correlate each of the items of The Tear Ballot for Industry. This was found by dividing the total time the wage earner had been in the labor market by the number of different jobs held during this period. The highest correlation existed between a worker's job tenure and the

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[6] This test is available from the Industrial Psychology Laboratory, Illinois Institute of Technology, Chicago, 16, Ill.

[7] Kerr, Willard A., On the Validity and Reliability of the Job Satisfaction Tear Ballot, *J. Appl. Psychol.*, 1948, 32, 275–281. By permission of the *Journal* and of the American Psychological Association.

TABLE 13–3. CORRELATION COEFFICIENTS BETWEEN TENURE RATE AND JOB-SATISFACTION ITEMS IN "THE TEAR BALLOT FOR INDUSTRY"*

1. Does the company make you feel that your job is reasonably secure as long as you do good work?	**.45**
2. In your opinion, how does this company compare with others in its interest in the welfare of the employees?	.14
3. How does your immediate supervisor compare with other managers, foremen, or section leaders as to supervisory ability?	.18
4. Consider your work, are your working conditions comfortable and healthful?	**.26**
5. Are most of the workers around you the kind who still remember you when you pass them on the street?	**.63**
6. Do you think your income is adequate for your living needs?	**.26**
7. Do you feel that you have proper opportunity to present a problem, complaint, or suggestion to the management?	**.28**
8. Do you have confidence in the *good intentions* of the management?	**.33**
9. Do you have confidence in the *good sense* of the management?	**.32**
10. What effect is your experience with the company having upon your personal happiness?	.17

* Coefficients significant at the 1 per cent level are set in boldface type. The remaining ones are significant at the 10 per cent level.

number of fellow workers who knew him by name on the street. This was interpreted by Kerr to indicate that the ability to make and retain friends over a period of time is a stable personality factor related to job adjustment. It was also found that all items correlate positively with tenure rate. These findings, although significant, must be verified with other groups before broad generalizations can be made. It is also questionable whether or not tenure rate is always a good criterion for testing job satisfaction. Tenure rate may result from increased responsibility and inability to secure other employment with similar compensation. However, the correlations between studies of tenure rate and of job satisfaction would indicate that it may be used as one criterion for measuring job satisfaction. The opposite of tenure rate is job dissatisfaction and employee maladjustment.

Employee-attitude Scales. Many studies of employee's attitudes have been conducted during the past two decades. These studies have been designed to furnish management with a more accurate idea regarding the general satisfaction or morale of the employees, and to provide information relative to specific attitudes toward policies of the company. The fact that attitude surveys are so widely used is evidence of their recognized value to many industrial and business concerns.

Uhrbrock[8] developed a scale consisting of 50 items for measuring the attitudes of workers toward the company's practices and policies. These ranged from extremely laudatory to critical and very unfavorable statements about the different policies. The following statements illustrate the nature of the items included in the scale:

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[8] Uhrbrock, R. S., Attitudes of 4,430 Employees, *J. Soc. Psychol.*, 1934, 5, 365–377.

Scale Value	Attitude Statement
10.4	I think this company treats its employees better than any other company does.
9.5	If I had to do it over again, I'd still work for this company.
8.9	A man can get ahead in this company if he tries.
8.5	The company is sincere in wanting to know what its employees think about it.
7.4	On the whole the company treats us about as well as we deserve.
5.1	The workers put as much over on the company as the company puts over on them.
3.6	I do not think applicants for employment are treated courteously.
2.9	My boss gives all the breaks to his lodge and church friends.
1.5	In the long run this company will "put it over" on you.
0.8	An honest man fails in this company.

Objective Evidences of Morale. In addition to the methods which have been described for determining the morale of employees, the following are objective criteria which may be used for ascertaining the morale of a group of employees:

1. Production which is lower than may be normally expected from the workers.
2. An unwarranted quantity of wasted or spoiled materials.
3. Undue absenteeism.
4. Excessive labor turnover.
5. Undue tension among workers indicated by conflicts on the job.

Why Workers Quit. In the solution of the many problems in the field of industrial relations, insufficient attention has been given to the underlying causes leading to dissatisfaction, to lowered morale, and to labor turnover. In recent times, the industrial relations departments of many concerns have become increasingly interested in conducting studies to determine causes of labor turnover. The studies conducted by the Industrial Relations Research Department of Lockheed Aircraft Corporation are noteworthy in this connection. An attempt was made to isolate and to study basic causes for workers quitting, rather than to analyze symptoms which are usually quite obvious to the student of industrial relations. The materials for the study were obtained from a series of interviews with 421 exemployees of the corporation.[9] Those interviewed were selected at random from the lists, and 35 questions sought reasons for quitting and questioned attitudes toward work, working conditions, supervisors, etc. These also were related to his home life, to home responsibilities, to family needs, and to his health status. The reasons given by these employees for voluntary termination were divided into two groups: (1) occupational and (2) personal.

The *occupational* items, accounting for 48 per cent of the terminations, are listed in order of importance:

Unsatisfactory placement
Desire to take another job
General dissatisfaction
Insufficient wages
Excessively heavy work
Unsatisfactory supervision
Poor working conditions

The *personal* reasons, accounting for 52 per cent, included:

Health
Child care
Transportation
Home responsibilities

The importance of these reasons varied with different groups of employees. Three-fourths of the men quit for occupational reasons, while three-fourths of the women quit for personal reasons. Most frequently, the younger men quit because of placement and job dissatisfaction; the men between the ages of twenty-four and thirty-seven quit because of wages; and the men above the age of thirty-seven quit because of personal reasons (largely health). Younger women quit because of child care while women of all age groups quit because of health. Health, wages, and personal problems were given as reasons for termination by married men more frequently than by single men. Married women quit largely for reasons of health, transportation, and placement. As seniority increased, the frequency with which men quit because of wages decreased. Among women (especially among those who were married) the percentage who quit because the work was too heavy increased with seniority.

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[9] Pamer, D. L., Purpus, E. R., and Stockford, Le Boron, Why Workers Quit, *Person. J.*, 1944–1945, 23, 111–119.

A careful study of the materials of Table 13–4 shows that there is a close relation between interest on the job and the amount of initiative demonstrated in the doing of it. In reply to the question presented in Table 13–2, it was observed that women seemed more thwarted than men. However, this cannot be interpreted as having a relation to their jobs since their interest in their work was as high as that shown by the men.

TABLE 13–4

Question: Does your job really give you a chance to try out ideas of your own, or not?

Answer	Total	Those who find present job			
		Interesting nearly all the time	Interesting most of the time	Dull most of the time	Completely dull
Yes, per cent	47	62	45	20	15
No, per cent	49	35	53	79	83
Express no opinion, per cent	4	3	2	1	2

MOTIVATION AND MORALE

HIERARCHY OF MOTIVES

There is some evidence that emotions may appear in a sort of hierarchy of potency. In such a case, the individual is interested in satisfying that motive which ranks first in potency with him. Once this motive is satisfied, the motive ranking next in the hierarchy becomes the one which is strongest in the individual's life desires. This view is expressed by Maslow[10] as follows:

> There are at least five sets of goals, which we may call basic needs. These are briefly, physiological, safety, love, esteem, and self-actualization. In addition, we are motivated by the desire to achieve or maintain the various conditions upon which these basic satisfactions rest and by certain intellectual desires.
>
> These basic goals are related to each other, being arranged into a hierarchy of propotency. This means that the most prepotent goal will monopolize consciousness and will tend of itself to organize the recruitment of the

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[10] Maslow, A. H., A Theory of Human Motivation, *Psychol. Rev.*, 1943, 50, 370–396. By permission of the *Review* and of the American Psychological Association.

various capacities of the organism. The less prepotent needs are minimized, even forgotten or denied.

The Fortune Survey and the study by Centers supports the theory of motivation set forth by Maslow. An analysis of the occupational differences expressed in the desire for security and for self-expression presented in Fig. 13–1 shows clearly that people in the lower occupational scale are dominated by a desire for security, while those in the higher scale, who would seem relatively free of this need, express a strong desire for opportunities for self-expression and interesting experiences. This should not be interpreted to mean that those of the lower scale have no desire for self-expression and for interesting experiences, but rather that the need for security ranks above the need for self-expression and for interesting experiences in their lives. These findings are important in un-

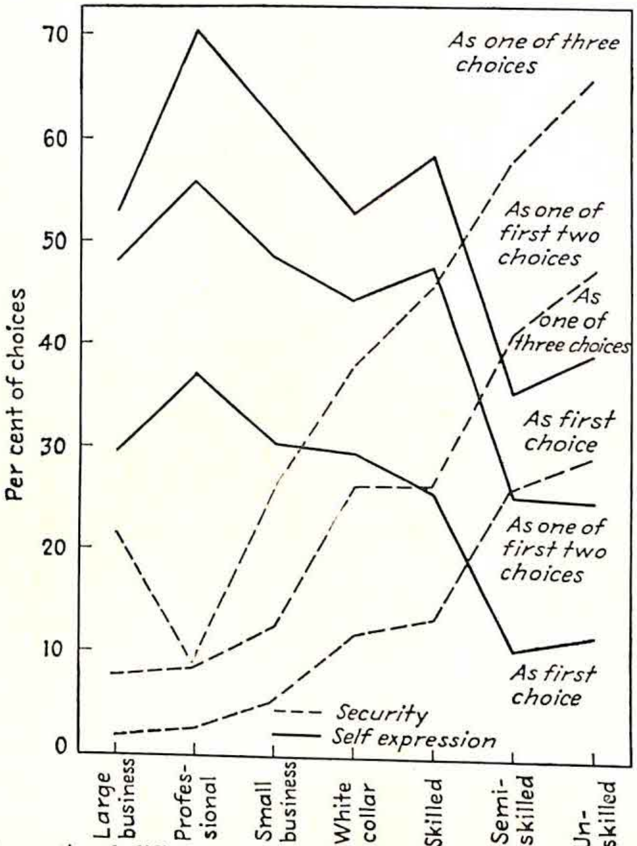

FIG. 13–1. Occupational differences in desires for security and self-expression. (*After Centers.*)

derstanding some of the basic factors in class conflicts pointed out by Centers[11] in his study. He states:

> One of the most potent factors setting any social group over against another is the existence of disparate sets of values between them, acting not only to promote solidarity within the separate groups but to kindle distrust and dislike of others whose values differ from theirs. It may well be that Management today sees Labor as a threat to its leadership, its self-expression, its independence or freedom, just as Labor sees in the tactic of Management the frustration of its own preeminent wants for security and independence. It is interesting to speculate as to what well-planned legislation designed to give the worker job tenure and a measure of autonomy in his work might do in restoring social harmony.

FUNDAMENTAL NEEDS OF WORKERS

Studies of the incentives of workers have borne out the fact that factors other than high pay loom large in their lives. The two fundamental needs of individuals have been classified by some students of human behavior as physiological and psychological. Any attempt to classify man's needs, however, meets with many difficulties. His needs are reflected in the incentives of workers and will vary with the nature and characteristics of individual workers. Maier[12] has brought together data from some of the studies conducted with different groups of employees. The materials from his analysis are presented in Table 13–5. An obvious fact revealed in this table is that steady work (security) ranks high in all the studies. This is in harmony with the results obtained by Centers for semiskilled and unskilled employees (see Fig. 13–1). Desirable working conditions appear to be more a urgent need for women employees than for men employees. Opportunity for advancement does not seem especially important for women factory workers, but it is most important for white-collar workers found, for example, in the department stores and business offices. Some of the major needs of workers are described more fully in the subsequent discussions.

Need for Security. Within the framework of industry and business there is a subordinate-superior relationship. To a marked degree the subordinate is dependent upon the superior for his job, for promotion, for responsibility, and for a number of other factors connected with the

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[11] Centers, Richard, Motivation Aspects of Occupational Stratification, *J. Soc. Psychol.*, 1948, 28, 215–216.

[12] Maier, N. R. F., *Psychology in Industry*, p. 268, Houghton Mifflin Company, Boston, 1946.

TABLE 13–5. ORDER IN WHICH CERTAIN MOTIVATING FACTORS APPEAL TO DIFFERENT GROUPS OF WORKERS

Incentive	Factory workers (women)	Department store workers	Miscellaneous workers	Union workers	Non-union workers	Average
Steady work	1	2	2	1	1	1.4
Comfortable working conditions	2	8	8	3.5	5	5.3
Good working conditions	3	7	7	....	..	5.7
Good boss	4	5	5	7	6	5.4
Opportunity for advancement	5	1	1	6	4	3.4
High pay	6	6	6	3.5	3	4.9
Opportunity to use own ideas	7	3	3.5	10	10	6.7
Opportunity to learn a job	8	4	3.5	....	..	5.2
Good hours	9	9	9	8	8	8.6
Easy work	10	10	10	....	..	10.0

TABLE 13–6*

Question (asked of men only): Here are three different kinds of jobs. If you had your choice, which would you pick?

Answer	Total, per cent	Professionals and executives, per cent	Salaried employees, per cent	Factory workers, per cent	Union members, per cent
A job which pays quite a low income but which you are sure of keeping	48.2	25.5	42.3	59.9	56
A job which pays a good income but which you have a fifty-fifty chance of losing	22.8	32.0	27.3	20.9	23.7
A job which pays an extremely high income if you make the grade but in which you lose almost everything if you don't make it	23.8	35.5	26.8	16.9	17.8
Don't know	5.2	7.0	3.6	2.3	2.5

* Reprinted from *Fortune* magazine, January, 1947, p. 10. Copyright Time, Inc.

work situation. The studies by Centers, the Fortune Survey, and other studies referred to earlier in the chapter reveal that the worker senses this (see Table 13–6). His desire for security and for fair treatment top the list of factors which promote job satisfaction. Management, recognizing this need for security on the part of employees, has attempted to satisfy it through retirement plans, health- and accident-insurance plans, annual-wage plans, credit unions, and the like.

Douglas McGregor has listed three major aspects of the subordinate-superior relationship which affect the security of the subordinate. The first and the one which he considers most important is referred to as "atmosphere." This is the general manner and behavior of the foremen and supervisors and their attitude toward the workers. The employee feels insecure unless he feels that his work and job activities meet with the approval of the foremen and supervisors. His second requirement for security is the need to know and understand what is expected of him. There is considerable information which the company should present to the employee so that his feeling of security is stabilized. He should know the rules and regulations of the company, the requirements of his job, the policies of the company, the attitude of the company toward union membership, his possibilities for promotion, and whether or not his work is satisfactory. The third source of security stems from a consistency in discipline. In this connection, discipline is regarded as having both a positive and a negative phase. In either case, it is important that all good discipline be consistent. The worker must be given unqualified support for his efforts as long as these are in harmony with information given him by the management. Insecurity arises among workers when they are not sure about the reaction of management to their action, even though their action is consistent with the policies set forth by the company. It is just as essential that workers be reproved for violation of principles which were explained and of which they were made aware at an earlier date.

Schuster[13] stresses the belief that industrial managers who show an interest in workers solely to increase production are taking a shortsighted viewpoint which will ultimately lead to a breakdown of morale and a failure to increase production. From an ethical standpoint, it is wrong to treat workers fairly and to praise them for their efforts merely as a means of increasing production. Good human relations should, according to Schuster, have a threefold purpose:

1. To achieve the optimum production.
2. To provide an activity which forms a basis for a good life for the individuals involved in production.
3. To coordinate the total program as an important part of the pattern of society.

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[13] Schuster, George, Human Relations in Industry, *Brit. Med. J.*, 1948, 1, 505–510.

Need for Recognition. The personal touch is more important than many executives realize. A large part of the secret underlying the excellent morale and success of concerns like Jack and Heintz, Inc., can perhaps be attributed to the practices of Jack himself and of the officers of the company.[14] The officers and salaried personnel of the organization eat in the company cafeteria with the shop and clerical workers. Jack, who attempts to become acquainted with all his associates, is referred to as Bill. Jack has the reputation for making good all his promises, and he shows a real concern for the welfare of his workers through his actions as well as through his words. Kouwenboven quotes the reply of a girl, who had been on the assembly line less than a year, to the committee's question: "What do you think of me?" (The *me* of the question referred to Jack.) "You have treated me as though I meant something to the good of your company," replied the girl. This reply appears to represent a basic factor found in good human relations. Employees desire to be treated as people "good for something." In the Jack and Heintz company, two fundamental principles of good human relations seem to be present. One is honesty and fair play in dealing with problems in which the workers are involved. The second is that implied in the response of the girl on the assembly line: a recognition of the worth of the worker and a genuine interest in the worker's welfare as a human being as well as a company employee.

Need for Sense of Personal Worth. There is, in addition to the need for security, a need for the worker to feel that he is of value to the concern. This need was fulfilled in a direct and concrete manner in earlier times when industries were small and each employee was concerned with the total production or manufacturing process. The large industries of today, intricately organized so that each worker performs his task according to an assembly-line procedure, do not provide the employee with the same kind of feeling about his position in the production process. Thus, one of the tasks with which many industries are very much concerned is that of providing agencies and means for the development of a feeling of personal worth, which can only come about as a result of a recognition of success or accomplishment.

Pride in Work Completed. Although man decries the reduction of the worker's pride and interest in a job as brought about by the increased use of the machine, he sees new and greater possibilities in pride of performance as a result of the power of his machine and the skill required in handling it. A fundamental difference lies in the fact that this pride must be shared with others producing the product. This may be illustrated by the following experience: On a trip through the Rocky Mountain area, the writer stopped to admire Buffalo Bill Dam, which had just been completed. A boy, about 10 years of age, was thrilled to tell about the dam, pointing out that his father helped with its construction. Although the father was probably one of a number of ordinary workers, it can truly be said that the efforts of everyone involved, from the humblest worker to the most competent engineer, contributed to the development of this tremendous structure. When the worker feels that he has a vital part in the construction of such a structure, or when the worker feels that he is needed in the manufacture of goods for the world market, his morale is improved.

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[14] See Jack and Heintz, *Life* magazine, 1943, 14, 74–81; Kouwenboven, J. A., Jack and Heintz—Factory or Free-for-all, *Harpers*, 1943, 186, 556–564.

Need for Belongingness. There is, then grave danger that the employees in our large industries may come to regard themselves as isolated workers doing some insignificant task if they are required, for example, to sand some pieces of lumber in a furniture factory. This is closely related to pride in work completed, referred to in a previous discussion. It makes a great deal of difference whether the worker regards himself as one sanding pieces of lumber or as one making pieces of furniture. In the latter case, the worker conceives of himself as a part of the total organization involved in the manufacture of furniture. He therefore speaks of the furniture as something "we" made. This feeling of belongingness may be considered from two angles. In the one case, the worker may develop such an over-all attitude toward the manufacturing concern and refer to it as "our" plant. Again, the worker may regard himself as an integral part only of those who are involved in the manufacture of certain types of materials. These are not, however, mutually exclusive; both attitudes may exist. The feeling of belongingness associated with such attitudes provides greater satisfaction and better adjustment for the individual employee.

The "Social Climate." The effects of the interaction of the workers should not be overlooked in a study of morale. The effect of the impact of members of a group on each other and upon their action as a group has been referred to as the "social climate." The importance of a desirable social climate has been revealed from the results of a number of studies in industry and in education. One of the earliest and most striking studies bearing on this problem was started by Western Electric in 1929.[15] The study, as originally planned, was designed to study the effects on production of varying the intensity of light in a factory. The results of the early experiments were somewhat confusing, since no consistent relation was found between variation in output and the intensity of light. Later experiments yielded results indicating that some variables which had not originally been considered as important apparently were affecting the results. In one case, output increased with an increase in the intensity of the light but failed to return to the original level after the light intensity was reduced. In another case, the control group working under a constant illumination condition showed gains approximating that of the experimental group which worked at varying intensities. In a later experiment, it was found that output increased for certain groups, even though the light intensity was actually decreased.

It was obvious that some factor or factors other than differences in light intensity were operating in these controlled experiments. These factors proved to be elements classified here as the social climate. For example, it was noted that morale could be built up more readily in groups that enjoyed being together socially. There was also an improvement of morale when a group spirit or "team consciousness" was present. Problems arose when there was a clash within a group due to differences in age, outlook, or attitude. And, in harmony with results presented elsewhere in this chapter, morale was higher when there was a friendly rather than autocratic atmosphere prevailing between management and workers. More and more industries are recognizing the importance and significance of these human factors, which is further evidence that individual workers cannot be dealt with as if they were machines. A recognition of the social elements in a working situation is absolutely essential if the maximum efficiency is to be secured and maintained.

UNIONISM AND THE NEEDS OF EMPLOYEES

For many people not in the laboring group, it is difficult to understand the problems, conditions, and forces which motivate laborers to organize themselves into unions. The unions of today are at base concerned with the same problems and policies they faced during the early days of their organization in America; however, they have broadened their activities to include factors related to education, hospitalization, and family welfare. Through an increased participation in the political life of the nation, they are making greater use of their strength. Universal education, adult-education programs, and the improved economic life in America have brought with them new and enlarged demands upon the workers. There is considerable evidence that unions are instrumental in improving the lot of the American worker, that they are fulfilling needs which are not usually satisfied by the impersonal large industries by which members are employed, and that they furnish the worker with a feeling of security, a feeling which was sorely lacking in the latter part of the nineteenth century. Collective membership in such an organization satisfies a need for belongingness and provides status which was denied the worker during the earlier stages of industrial organization. According to the Golden and Ruttenberg,[16] workers organize into labor unions because of economic, social, and political motives. They are especially concerned with policy making and decisions which may affect their lives either directly or indirectly. The psychological effects of unionism on the worker have been described by Leo Chalfen[17] as follows:

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[15] Roethlisberger, F. J., Dickson, W. J., and Wright, H. A., *Management and the Worker,* Harvard University Press, Cambridge, 1939. This study has been summarized by Watson, G. B., in The Surprising Discovery of Morale, *Prog. Educ.* 1942, 19, 33–41.

> Status and self-integrity are psychologically grounded in the same theory. Individual values determine the relative influence of social and personal standards and attitudes. . . . Social recognition therefore is dependent upon union membership in certain milieux. Self-regard is a function of the lack of discrepancy between principle and operation. Since everyone is supposedly helping everyone else in the group as well as himself through union activity, feelings of altruism do occur. However, by virtue of the same process, some may consider themselves personally penalized (egotism) since the group is concerned with the group as a whole. Others lose themselves in the collective approach of the organized membership.

RELATIONSHIP OF MOTIVES TO VARIOUS OCCUPATIONAL LEVELS

Centers[18] conducted a study to determine the differences in point of view, if any, which exist among people of differing socioeconomic strata. These may help to explain the opinion held by workers regarding industrial executives and by executives regarding workers. A cross section of the adult male population was polled on a number of leading questions through the person-to-person interview technique.

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[16] Golden, C., and Ruttenberg, H., *The Dynamics of Industrial Democracy,* Harper & Brothers, New York, 1947. It should be noted here that these powerful leaders of the steel workers emphasize the importance to the worker of participation in decision making rather than economic gains.

[17] Chalfen, Leo, The Psychological Effect of Unionism on the Member, *J. Soc. Psychol.,* 1947, 25, 135.

[18] *Op. cit.*

One of the questions asked was: "Do you think all the modern scientific inventions of new machines and materials will result in a better standard of living for all of us, or do you think these things have been overrated?" The answers to this question indicated that the majority of all groups believed that the machines of today have made possible a higher standard of living for all. However, they indicated occupational differences in confidence and enthusiasm for our modern technological developments. This is shown in Table 13–7. Approximately 85 per cent of the large business owners and managers responded: "better standards of living." None of them indicated that machines created unemployment. In contrast to this, only 58.4 per cent of the unskilled workers showed this enthusiasm for the machine, while almost 21 per cent indicated that it was overrated. Six and one-half per cent stated that it created unemployment. Among rural peoples, confidence in the value of the machine is high, with little difference shown between the two strata groups.

TABLE 13–7. ATTITUDE DIFFERENCES OF OCCUPATIONAL STRATA: CONFIDENCE IN MODERN TECHNOLOGY

	N	Better standard of living, per cent	Overrated, per cent	Machines create unemployment, per cent	Other answers, per cent	Don't know, per cent
National	1,092	72.5	17.9	1.6	1.9	6.1
Urban:						
All business, professional and white collar	429	78.1	15.9	1.2	2.3	2.5
All manual workers	410	64.9	19.8	2.9	1.7	10.7
Large business	53	84.9	13.2	0.0	1.9	0.0
Professional	73	76.7	15.1	1.4	5.4	1.4
Small business	131	75.6	17.6	0.8	2.3	3.7
White collar	172	78.5	15.7	1.7	1.2	2.9
Skilled	161	69.6	18.0	1.2	1.9	9.3
Semiskilled	172	63.4	20.9	2.9	2.3	10.5
Unskilled	77	58.4	20.8	6.5	0.0	14.3
Rural:						
Farm owners and managers	153	73.9	20.3	0.0	1.3	4.5
Farm tenants and laborers	69	78.3	16.0	0.0	1.4	4.3

Centers also asked: "Do you think that most people who are successful are successful because of ability, luck, pull, or because of the better opportunities they have had?" There is evidence from the answers to this question that the idea that any industrious and thrifty individual can achieve great success is fading out, and that the average American citizen is being more realistic in his evaluation of the milestones in the road to success. The results presented in Table 13–8 show a significant difference in the responses to the question of the different socioeconomic groups, and illustrate a progressive decline, from the large business groups on through to the manual groups, in faith in ability as a means of attaining success. Also, while over one-half (56.2 per cent) of the farm owners and managers gave ability as the factor responsible for success. only 31.9 per cent of the farm tenants and laborers gave this as the important factor. *Pull* and *luck* were regarded by the manual workers as

TABLE 13–8. ATTITUDES OF OCCUPATIONAL STRATA: WHY PEOPLE SUCCEED

	N	Ability, per cent	Ability plus other factors, per cent	Luck, per cent	Pull, per cent	Better opportunities, per cent	Combination of luck, pull and opportunity, per cent	Don't know, per cent
National	1,092	45.1	14.4	6.1	7.5	20.3	2.8	3.8
Urban:								
All business, professional and white collar	426	52.1	19.2	2.6	6.2	16.4	2.1	1.4
All manual workers	413	35.8	12.2	9.4	11.9	21.0	4.1	5.6
Large business	54	62.3	20.8	0.0	0.0	16.9	0.0	0.0
Professional	73	46.6	31.5	2.7	5.5	11.0	2.7	0.0
Small business	129	51.9	20.2	3.1	6.2	14.7	1.6	2.3
White collar	171	51.5	12.9	2.9	8.2	19.9	2.9	1.7
Skilled manual	162	41.9	14.8	6.8	10.5	19.1	2.5	4.4
Semiskilled manual	174	34.5	10.9	8.6	11.5	23.6	5.7	5.2
Unskilled manual	77	25.9	9.1	16.9	15.6	19.5	3.9	9.1
Rural:								
Farm owners and managers	153	56.2	9.2	5.9	3.3	21.6	1.3	2.5
Farm tenants and laborers	69	31.9	8.7	11.6	2.9	36.2	1.4	7.3

most important factors for success, while none of the large business executives considered them important.

This same trend was also apparent in connection with responses to the following questions: "Why do you think some people have been able to get rich? Is it because of ability, luck, pull, their better opportunities, or something else? Why do you think some of the people are always poor?" The differences in the responses of the various strata groups was greater for the first question than for the second one. There seemed to be a general feeling among all groups that "poor management" was an important reason why some people are always poor. Laziness, lack of opportunity, lack of ambition, lack of ability, bad luck, lack of education, and ill health were cited by a substantial number in each strata. Poverty, to a much greater degree than riches, was in most cases largely attributed to the faults of the individual.

The responses to the questions dealing with wages and earnings of the various socioeconomic strata groups have been summarized as follows:[19]

> . . . Lower occupational strata differ from higher groups in their beliefs about the pay of certain higher groups, namely doctors and lawyers. More of the former believe doctors and lawyers to be overpaid than do persons in higher occupational categories.
>
> . . . Differences of view with respect to what occupational groups are underpaid are small, but there is a clearly apparent tendency for persons of a given occupational stratum to say, more frequently than persons of other strata do, that it is their own or a similar occupational stratum that is underpaid.

As noted before, the 50 items of Uhrbrock's attitude scale[20] were tested on 4,430 employees—3,934 factory employees, 96 clerical workers, and 400 foremen. The factory superintendents were assembled, given the directions, and told that they were not to sign their names to the blanks. Significant differences in the mean score were obtained from the three groups of employees. These differences are shown in Fig. 13–2. The mean scores of the foremen on the attitude scale were higher than those of the workers in each of the 12 factories where the test was given.

METHODS OF BUILDING MORALE IN INDUSTRY

The building and maintenance of employee morale is one of industry's most pressing problems. During the Second World War when problems were many and all-out production was vitally necessary, considerable progress was made. One of the most significant changes was in the attitude of management as shown by an increased recognition of the importance of worker morale and by the launching of specifically designed morale-building programs.

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[19] *Ibid.*, p. 184.

[20] *Loc. cit.*

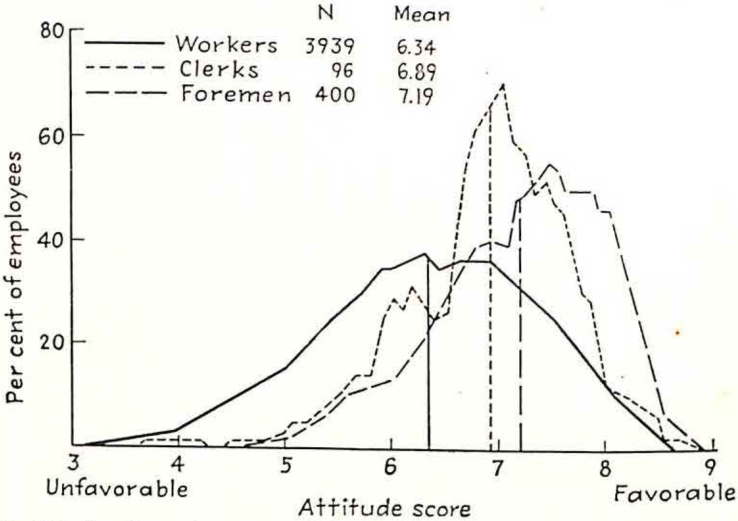

FIG. 13–2. Distribution of scores of factory workers, clerks, and foremen on the attitude scale. (*After Uhrbrock.*)

THROUGH A FAIR WAGE POLICY

It has already been suggested that the wage scale has come to play a less exclusively important role in connection with morale than it formerly held. There are, however, factors related to the administration of the wage scale that have an important bearing on the morale of the group.

1. Workers expect a fair wage. This is to a degree a relative term. A fair wage might be regarded as that which compares favorably with that of other workers in somewhat similar employment.

2. A fair wage may be evaluated in terms of the earnings of the company.

3. A fair wage should be developed and administered in terms of the worth of a particular job in comparison with other jobs of a given concern.

4. Wage differentials should be established on a sound and, in so far as possible, scientific basis. These should be of such a nature that they can be evaluated, so that the worker can understand why his job pays more or less than another job with the concern.

5. Wage payments should be made according to contractual agreement.

According to Aspley and Whitmore,[21] men work basically for some reward. When they feel that they are not being fairly paid or when they feel that the wage scale is unfair or poorly administered, morale will be adversely affected.

THROUGH GROUP PARTICIPATION IN POLICY MAKING

When employees have achieved a reasonable degree of security they will feel the need for the realization of self. The workers of today are better informed about company policies, economic problems, and other matters related to production, than at any time in the history of our country. Thus, they are in a better position to participate in discussions of changes, policies, and other matters which affect their lives. There are several levels of participation. On the one level, the worker simply attends meetings and listens to discussions, but does not enter into them himself. At the second level, which may be referred to as the discussion level, the worker attends meetings where matters directly affecting him are being discussed. He may enter into the discussion but with no voice in voting. At a still higher level of participation, the worker attends meetings, enters into the discussions, and has a voice in settling issues. The level of participation will depend upon the ability and readiness of employees for such participation. It might be stated, as a general principle, that the development of such a program of employee participation should be gradual in nature.

Democratic procedures are being used, extensively, by large industries and small concerns alike. Collective bargaining itself is based upon the assumption that men can work together in settling their differences. The National Planning Association recently conducted five case studies on the causes of industrial peace under collective bargaining.[22] As a result of their studies they conclude: "Our evidence suggests, however, that if the local company or plant relationship is healthy and strong it will often weather disturbances that are industry-wide or national in scope."

Autocratic, Democratic, and Laissez-faire Controls. The relationship between autocracy and democracy, and complete individual freedom

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[21] Aspley, J. C., and Whitmore, Eugene, *The Handbook of Industrial Relations*, The Dartnell Corporation, Chicago, 1944.

[22] See They Wage the Peace, *Bulletin of the National Planning Association*, Washington, D.C., 1949. This Association has undertaken to study the problem of how industrial peace of a constructive character can be won, by providing a record of typical cases illustrating how this has been accomplished.

(*laissez-faire*) is poorly understood by the average teacher, manager, or supervisor. The relationship is usually conceived of as following a linear scale represented by *laissez-faire* at one end and autocracy at the other. These two represent the extremes, with democracy placed somewhere midway between them.[23] Lewin illustrates the fallacy of such a concept. He regards the relationship of these forms of control as triangular in nature (see Fig. 13–3). Since both democracy and autocracy are composed of controls and leadership, they are somewhat similar and may be thought of as having a linear relationship. In such a case, democracy, with control in the hands of the people, is placed at one extreme on the line, and autocracy, with highly centralized control, is placed at the other extreme. The line between democracy and autocracy represents a continuum showing all degrees from a highly centralized type of control to that of complete group responsibility. There may be, however, a general diminution of control. In such a case, we have a condition at *LF* where *A* and *D* converge. At this point, there is an absence of controls, with complete individual freedom and chaos existing.

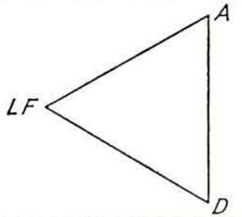

FIG. 13–3. The relationship of autocracy (*A*), democracy (*D*), and *laissez-faire* (*LF*). (*After Lewin.*)

The point separating democratic control from autocratic control is an arbitrary one. There are all degrees of each type of control, and according to the illustration presented in Fig. 13–3, one fades off into the other. The use of democratic methods does not mean that the workers are called together to vote on each problem that arises. A distinction must be drawn between problems requiring knowledge and expert opinion and those involving attitudes and feelings. At times the foreman or supervisor may act in the capacity of an expert to provide expert opinion. Specialists from various areas would be called upon for the solution of certain types of problems even in a democratically controlled group. The chart presented in Table 13–9 gives a general description of the operation of the democratic procedure (p. 342).

Many leaders fear that their leadership will be weakened by the use of group discussion in arriving at the solution of a problem. Experiments by Alex Bavelas, conducted in industry, under controlled conditions, showed a significant increase in production following the introduction of team decisions.[24] This is shown for sewing-machine workers in Fig. 13–4. The production curve showed a very significant rise immediately upon the application of group-decision practices.

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[23] Lewin, Kurt, The Dynamics of Group Action, *Educ. Leadership*, 1944, **1**, 195–200.

Much of the misunderstanding between management and labor is based upon what might be termed faulty concepts regarding each other. The industrial executive may conceive of the worker as lazy, irresponsible, ignorant, and lacking in ambition. Many of the workers regard the managers as haughty, ruthless, greedy exploiters grasping for power. Such concepts lead to distrust, significant barriers to good industrial relations.

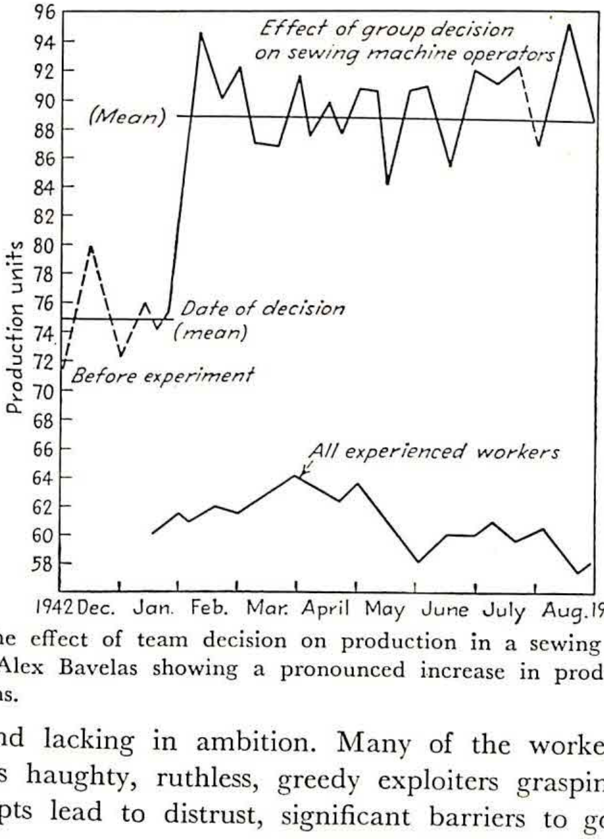

FIG. 13–4. The effect of team decision on production in a sewing factory. An experiment by Alex Bavelas showing a pronounced increase in production following group decisions.

There is a very real need for workers and management to understand each other better. This can best come about through social contacts and group participation in policy making under conditions involving a minimum amount of tension. Concerning this problem, William R. Burrows, vice-president in charge of manufacturing, General Electric Company,[25] stated:

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[24] *Ibid.*, pp. 197–198.

[25] Burrows, William R., Management in Evolution, *Survey Graphic*, 1941, 30, 594.

If we believe in the principles of democracy, in the fundamental integrity and the essential honesty of the common man, we must assume that the problems of management and labor arise, not out of the selfish desire on the part of management to exploit labor, or the equally selfish desire on the part of labor to take advantage of management, but out of misunderstanding and ignorance.

Table 13–9. COMPARISON OF AUTHORITARIAN AND DEMOCRATIC ORGANIZATION AND CONTROL IN INDUSTRY

Authoritarian	Democratic
All policies are determined by a few individuals—sometimes by a single individual	Policies affecting the workers are a matter of group discussion and decision under the guidance and direction of leaders
Techniques and policies are dictated by management as the need arises	Techniques and developments are planned for ahead of the time when they are to be put into effect. The group is aware of the future plans and has had a voice in the development of such plans
The leaders (foremen, supervisors, and others) are chosen by the authority (executives), subject to the authority, and respond to the viewpoints and wishes of the authority	The leaders (foremen, supervisors, and others) are selected on the basis of suggestions coming from the employees
The leader dictates the work tasks, schedule, changes, etc.	The work tasks, schedule, and conditions of work are discussed with the employees. They are given an opportunity to express their ideas and feelings
The leaders, although friendly to the employees, regard themselves in a different social category and remain aloof from them in social and recreational programs	The leaders attempt to enter into the social and recreational life of the group, but do not enter into the work tasks on the level with the group
The leaders are personal in their praise and rewards, oftentimes showing favoritism based upon cooperation with management	Praise, rewards, and criticisms are given on the basis of merit. Practices and policies will be consistent with the feelings and aspirations of the group
Information concerning the policies, earnings, and plans for future expansion is given out to the extent that management considers such information will promote good morale and increase production and efficiency	Information concerning the policies, earnings, and plans for the future is made known to the employees, and discussion and study groups are formed for making special recommendations

THROUGH EFFECTIVE COMMUNICATION

Business and industry are constantly faced with the problem of finding the most desirable and effective method of communicating with workers.

In general, more than one procedure needs to be available, since some messages are more effective if presented in one manner, while other messages are more effective if presented in another. Thus, the method employed should depend upon the nature and the purpose of the information. Signs may be effective as a means of accident prevention if placed in a strategic location where danger often lurks. Thought-provoking messages may best be placed in the hands of the workers to be taken home through some such means as the company paper.

Communications concerning policies are *best* understood if they are *easily* understood, if they are written in an easy conversational style, and if they are presented in a layout with quick eye appeal.

Often the plant newspaper serves as an excellent means of management communication with workers. Its purpose should be to provide news of interest concerning the company and its personnel. "Mr. and Mrs. Sam Doe are now recovering from an automobile accident." Such information with details concerning the incident serves to develop a feeling of the concern as a unit. "Our Company is developing a new material." Such information with details again serves to develop a family of "oneness."

Rumors of an adverse nature (these make a good story and spread most readily) tend to produce decreased morals and an excessive labor turnover. Some industrial concerns have installed "rumor clinics" as a means of combatting the spread of harmful rumors. The Sylvania Electric Products Company of Towanda, Pennsylvania, has established what appears to be an excellent procedure for dealing with rumors.[26] Their rumor clinic was established in the summer of 1947. At that time, boxes were placed in the restrooms, the cafeterias, and other places in the plant convenient for the workers. The employees were invited to deposit in these boxes any questions about which they desired more accurate or more complete information. Forms were supplied for submitting questions, which could be deposited either signed or unsigned. The questions were to be answered in the house magazine *Powder and Rod*. Since the inauguration of the plan, questions asked have covered problems related to the retirement plan, company policies toward the union, reemployment of veterans, and the like. The personnel manager at the plant reported that at the beginning many questions appeared. The number later declined. But the rumor clinic at Towanda was such an over-all success that similar clinics have been established in other Sylvania plants.

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[26] Rumor Clinic a Good Move, *Off. Mgmt. and Equip.*, December, 1948, p. 26.

THROUGH THE WORKING ENVIRONMENT

The industrial worker performs his tasks in a complex physical environment. The physical environment is usually simpler to define, analyze, and control than the social environment, but it is a mistake to minimize the significance of either. Most modern concepts, whether in physics or psychology, embody the viewpoint of the field theory, viz., that all natural events are functions of the "field" in which they occur. A gray piece of paper on a blue background looks tannish and on a yellow background looks bluish—all because the larger frame of setting affects the visual qualities of the "enclosed" object. In a similar sense, the organism is affected by the nature of the field in which it operates. This means, then, that the industrial worker finds his operations modified by the physical and social attributes of his working environment.

Providing a Good Physical Environment. Although the electric-power companies have a vested interest in the greater use of their product, it is difficult for the illuminating engineer to overstate his case. One of them has pointed out that[27]

> A survey of what good lighting means to industrialists brings out the significant fact that employers are more conscious today than ever before of the human element in production. With better lighting, not only is greater productive effort obtained, but the better lighting goes far to thwart the spirit of defeatism which may be an underlying cause of labor unrest.

To the thoughtful employer, good vision in the working environment is definitely connected with increased production, with improved quality of materials, with a decline in accidents, and with a decrease in the amount of waste in the handling of materials. An interest in improved lighting conditions is an illustration of a "common denominator" uniting all persons connected with the industrial operation.

What has been said about adverse lighting conditions becomes applicable to unpleasant noises and disagreeable temperature conditions. The "putt-putt" sound of a new motorboat engine and the noisy action of the old engine shows that an auditory experience varies with the nature of the sound and what it signifies. In one case, the meaning is satisfying; in the other, it is annoying to the trained mechanical-minded ear. Sanitary conditions and other facilities have an important bearing on the morale of employees. The extent to which such factors influence morale will depend to a large measure upon the background of the employees. Workers accustomed to wearing clean clothes on the streets and having clean hands will not be satisfied with inadequate washroom facilities. Workers accustomed to taking care of their clothing will complain if no provision is made for storing coats, etc., during working hours. The provision of clean restrooms, of adequate water, and of lockers for clothing will do much to create a favorable attitude toward the concern.

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[27] Brown, W. C., The Year's Progress in Illumination, *Trans. Illum. Engng. Soc.*, 1937, 32, 889–890. Perhaps the reader should be warned at this point against adopting any single physiological explanation for "labor unrest." This vast phenomenon has many sources and is a far more complex affair than most persons realize.

Providing a Favorable Social Environment. The effects of the specific social environment upon the morale of a group will vary to some extent from individual to individual. This problem, then, is closely related to the selection and placement of workers. Since every experience is an interaction between the individual and his environment, naturally the effects of the environment surrounding the employee will have a direct bearing upon his experience. A congenial social environment is just as important for the development of teamwork and good morale as a favorable physical environment. Mythical all-American teams may fail to perform as brilliantly as expected because of maladjustment within the group. The psychological whole is, in very truth, something other than the mere sum of its parts.

Many industries are making definite provisions for recreational activities among workers. In some cases, club houses are now provided. These provide a variety of games. Parks, picnic grounds, swimming pools, and other recreational provisions are provided by some concerns for the exclusive use of their employees. Chrysler Corporation is said to buy bats by the carload for baseball teams among its workers. Goodyear has a $2,500,000 recreation hall with bowling alleys and other provisions for games. General Electric workers in Cleveland boast of 20 golf teams. Victor Riesel, a newspaper columnist, has pointed out that American employers are spending $300,000,000 a year an recreation programs. These unquestionably pay good dividends in the form of better health, improved attitudes toward the company, reduced emotional tension, and better morale on the part of the workers.

SUMMARY

The recognition by business and industry of the importance of social and personal factors in the satisfaction and productivity of workers evolved as part of the total development of a greater concern for the total needs and for the welfare of American citizens. Concerning this, Loken[28] has stated:

> This public recognition of responsibility has been translated into certain rights and privileges which will operate to provide the individual worker with job security. It has also resulted in numerous major changes in industrial-relations policy. For example, no more than twenty years ago such services as housing, child care, education, insurance, hospitalization and medical care were looked upon as special privileges or premiums to be offered or withheld as management desired. Today, these same services are expected, and taken for granted, by large numbers of workers in business and industry. This has come about because management has learned that it pays off in production to recognize and consider the needs of the individual.

The Labor Committee of the Twentieth Century Fund has set forth the bases for management-labor understanding.[29] This committee analyzed the goals of both labor and management and studied the attitudes of each toward the goals of the other. From a study of labor relations existing during the past decade, the committee observed evidences of increased cooperation between labor and management. There is further evidence of a change in the nature and function of industry from that of the militant and uncompromising leader to one which is able to work with and to understand its workers.

Four major objectives are ascribed to labor by the committee. First, there is a desire for security. The studies referred to in this chapter have shown this to be very important in relation to employee morale. Second, labor desires an opportunity to advance. There is a strong feeling among the more experienced workers that their chances of advancement are poor despite any efforts which they may make. There is evidence that this want, per se, is not as important as some would indicate. Third, the worker of today wants to be treated and respected as a human being. Fourth, labor desires status, a sense of dignity, and a feeling of personal worth. In short, he wants a "pat on the back" for work well done, not just a "verbal kick" when things go wrong. This fourth point leads the worker to seek recognition.

The vast amount of experimentation now being conducted by various industrial concerns furnishes evidence for the conclusion that the problem of worker morale is of utmost importance and that management is increasingly attempting to find means of improving human relations in industry.

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[28] Loken, R. D., Warm or Cold Management, *Person. J.*, 1946, 24, 309.

[29] Labor Committee, Twentieth Century Fund, assisted by Osgood Nichols, Partners in Production—A Basis for Labor-Management Understanding, *Report*, Twentieth Century Fund, New York, 1949.

RECOMMENDED READINGS

Aspley, J. C., and Whitmore, Eugene: *The Handbook of Industrial Relations,* The Dartnell Corporation, Chicago, 1944.

Bellows, R. M.: *Psychology of Personnel in Business and Industry,* Chaps. 10, 12, Prentice-Hall, Inc., New York, 1949.

Benge, E. J.: *How to Make a Morale Survey,* National Foreman's Institute, Inc., New York, 1941.

Blum, M. L.: *Industrial Psychology,* Harper & Brothers, New York, 1949.

Calhoon, R. P.: *Problems in Personnel Administration,* Chaps. 19–20, Harper & Brothers, New York, 1949.

Camp, G. L.: Morale in Industry: A Selected Reading List, *Occupations,* 1949, 27, 476–477. A selected bibliography of 45 items covering the 10-year period prior to April, 1949, is here presented.

Chamberlain, Neil W.: *The Union Challenge to Management,* Harper & Brothers, New York, 1948. This is a splendid presentation of the pro's and con's of the problems related to management and the challenge of unions.

Child, I. L.: Morale: A Bibliographical Review, *Psychol. Bull.,* 1941, 38, 393–420.

Drake, Frances S., and Drake, Charles A.: *A Human Relations Casebook for Executives and Supervisors,* McGraw-Hill Book Company, Inc., New York, 1947. Seventy-five case histories drawn from actual experiences in industry are presented.

Maier, N. R. F.: Psychology in Industry, Chap. 5, Houghton Mifflin Company, Boston, 1946.

McMurry, Robert N.: *Handling Personality Adjustment in Industry,* Harper & Brothers, New York, 1944.

Moore, Herbert: *Psychology for Business and Industry,* McGraw-Hill Book Company, Inc., New York, 1942.

Nash, J. B.: *Building Morale,* A. S. Barnes and Company, New York, 1942.

Roethlisberger, R.: *Management and Morale,* p. 194, Harvard University Press, Cambridge, 1941.

Thomas, C. C.: *Human Relations in Action,* Prentice-Hall, Inc., New York, 1947.

Tiffin, J.: *Industrial Psychology* (2d ed.), Chap. 14, Prentice-Hall, Inc., New York, 1947.

Ward, Roswell: *The Personnel Policies of Jack and Heintz,* Harper & Brothers, New York, 1946.

Watkins, G. S., and Dodd, P. A.: *The Management of Labor Relations,* McGraw-Hill Book Company, Inc., New York, 1938.

Watson, G. (Ed.): *Civilian Morale,* Society for the Study of Social Issues, Houghton Mifflin Company, Boston, 1942.

Whitehead, T. N.: *The Industrial Worker,* Vol. 1, Chap. 25, Harvard University Press, Cambridge, 1938.

Chapter 14

EMPLOYEE ADJUSTMENT*

- The Meaning of Adjustment
  - Modern Concepts of Adjustment
  - Satisfaction and Adjustment
  - Significance of Industrial Maladjustments
    - Social Maladjustments
- Symptoms of Maladjustment
  - Effects of Maladjustment upon the Worker
  - Absenteeism and Maladjustment
  - Sickness Rate as an Index
    - Physical Disability Resulting from Vocational Maladjustment
  - Discontent among Employees
- Basic Causes of Maladjustment
  - Variables in Adjustment
  - The Job and Maladjustment
    - Income and Dissatisfaction
    - Insecurity and Maladjustments
    - Occupational Level and Maladjustments
  - Home and Community Factors
    - Unfavorable Home Conditions
    - Undesirable or Inadequate Social and Recreational Contacts
  - Personality Factors
    - Conflicts between Motives
    - Level of Aspiration
    - Employee Anxiety and Frustration
    - Health
  - Maladjustments Peculiar to Women
- Treatment of Maladjustments
  - Importance of Early Detection
  - Need for Outlet for Emotional Tension
  - Need for Counseling
  - Employee's Mental Hygiene
  - Industrial Psychotherapy—Goals and Methods
- Summary

THE MEANING OF ADJUSTMENT

Modern Concepts of Adjustment

The problem of maladjustments becomes less troublesome if certain concepts are first clarified. To the biologist, adaptation is any change in the organism, either in structure or in function, which renders it more able to maintain itself and perpetuate its kind. When the organism is successful in such an adaptation it may be said to be adjusted; when unsuccessful, maladjusted. To the sociologist, adjustment refers primarily to the ability of the organism to fit into its environment. Maladjustments result from a lack of appropriateness of the behavior of the individual as it relates to his environment. The problem of just what type of behavior is appropriate for a specific situation is not always easy to determine. These concepts indicate that maladjustment involves the ability of the organism to adjust his behavior in harmony with certain environmental conditions or requirements. Vocational maladjustment is one form of such inappropriate behavior—a condition resulting from an attempt to pursue an occupation for which the individual is not by training, potential ability, or otherwise suited. However, since the individual is an organized whole, maladjustment in any area of his life may have an adverse effect upon his adjustment on the job.

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* This chapter was written by Dr. Karl C. Garrison.

Satisfaction and Adjustment

The concept of satisfaction as the goal of human adjustment and as an important factor to be reckoned with in human efficiency has been emphasized by Poffenberger[1] as well as by other students of applied psychology. Such a concept is directly in harmony with the social trend in the democracies toward an increased concern for the welfare of the masses and the happiness of the individual. Satisfaction or dissatisfaction refers to the way one feels about a thing, condition, person, or situation. It is closely related to the feeling or emotional phase of experience, although one might better state that it involves the whole self. Satisfaction is to be regarded in general as a pleasant state, while dissatisfaction is regarded as an unpleasant one, although it is not possible to present a complete and exact characterization for them. There is, however, adequate justification for assigning a close relation between satisfaction and adjustment in everyday affairs. A spirit of satisfaction on the part of the individual worker will make his work appear to run smoothly and his associations pleasant. This spirit of satisfaction pervades all his activities and is a part of the "total self."

Significance of Industrial Maladjustments

The extent and variety of maladjustments among business and industrial employees present critical social, economic, and psychological problems.[2] The economic and social changes of the past century brought forth many new problems involving human relations. Maladjustments, inefficiency, and job dissatisfaction found among workers are closely related to these changes. Lack of adaptation to these economic and cultural changes is not peculiar to employees; proportionally, it may even be greater among employers who do not understand, or are not sympathetic with, the events and forces affecting them. However, those in control have a greater measure of financial and emotional security than the workers on the assembly line; consequently, maladjustments are profoundly more disturbing and of more serious consequence to the worker, since his job is for him the focal point of his life. Unhappiness and failure here affect every other phase of his life demands and plans. Status and a feeling of personal worth—fundamentals for a well-adjusted personality—are seriously affected and lowered. The responsibilities for these maladjustments are hard to locate; but a recognition of the nature of the problem is the first essential for any remedial and preventive program.

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[1] Poffenberger, A. T., *Principles of Applied Psychology,* Chap. 24, Appleton-Century-Crofts, Inc., New York, 1942.

TABLE 14–1

Question: If you could go back to the age of fifteen and start life over again, would you choose a different trade or occupation?

Yes	No	No opinion
57%	31%	12%

Question: For a person in your trade or occupation do you think your company is about as good a place as there is to work, or do you think there are other places that are better?

Our company as good	Other places are better	No opinion
72%	17%	11%

The financial loss to industry caused by misfits, reckoned in terms of their mistakes, accidents, absenteeism, wastefulness, ineptness, and vacillations, are enormous. Yet, the employer is oftentimes reluctant to dismiss them—in the case of the younger worker out of sympathy and in the case of the older worker out of appreciation for his past services and concern for him and the members of his family. The maladjusted worker often becomes a charge to the employer, to the trade union, and to the state.

There are other aspects of vocational maladjustment which will be presented later in this chapter. Personal and social adjustments are definitely related to vocational adjustments. Also, the aspirations and needs of the worker are closely connected with maladjustments on the job. Mass production, specialization of labor, lack of opportunity for self-expression, feelings of insecurity, and other factors and conditions must be included in any consideration of the worker's well-being and his success on the job. These are but the products of technology.

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[2] Table 14–1 presents materials from a survey conducted by *Fortune* magazine which bears on this problem. The data presented in this table show a feeling of dissatisfaction among over 50 per cent of workers surveyed; however, most of them felt that their company was about as good to work for as any. This table is reproduced by permission of *Fortune* magazine, January, 1947. Copyright Time, Inc.

Social Maladjustments. In Hanna's[3] comparative study of two categories of workers, the maladjusted group, despite their more advanced median age (approximately 2 years), does not show as good job stability as the adjusted group. On the Otis self-administering Tests of Mental Ability as well as on the Thorndike Test of Word Knowledge, the adjusted group was slightly superior, although the differences were not statistically significant. A further analysis of the data showed that if a worker is poorly adjusted he suffers not only difficulties in social adjustment, but reduced earnings as well (see Fig. 14–1). Furthermore, he suffers from the probability of increased accidents and many similar handicaps, all leading to the creation of a truly vicious circle of "misfortunes" from which he is unable to extricate himself without heroic personal effort or skillful outside intervention. These conditions have serious consequences

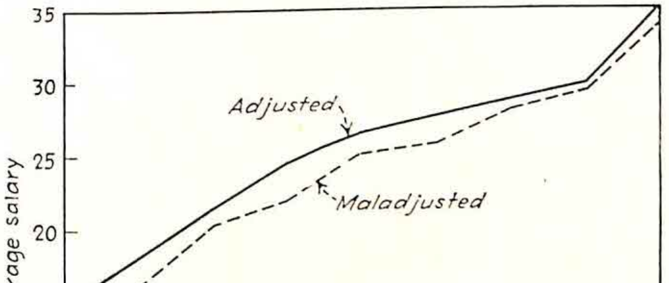

FIG. 14–1. Comparison of average salaries of adjusted and maladjusted subjects at different age levels. (By permission, *J. Abnorm. and Soc. Psychol., and American Psychological Association.*

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[3] Hanna, J. V., Job Stability and Earning Power of Emotionally Maladjusted as Compared with Emotionally Adjusted Workers, *J. Abnorm. and Soc. Psychol.,* 1935, 30, 155–163.

on the happiness of the worker and his relations to his family, friends, and others with whom he is associated.

SYMPTOMS OF MALADJUSTMENT

Effects of Maladjustment upon the Worker

The extent to which maladjustments affect individual workers cannot be measured with any degree of accuracy, but there is much evidence that such maladjustments have serious consequences for a great many employees. Increased susceptibility to accidents, excessive waste, loss of emotional balance, unhappiness in the home and other phases of life away from the work result from a worker's trying to do a job for which he is ill-adapted. These effects, when carried into the home, may create serious domestic difficulties and thus affect every member of the particular family unit. They may also affect the employee's social and recreational life and do irreparable damage to his character, reputation, and happiness.

Poorly adjusted people tend to exaggerate their troubles, and this, of course, leads to further maladjustments. They tend to feel that others have it in for them. They regard their misfortunes as being born of hard luck over which they themselves have little control. They lose confidence in others and in doing so lose their friends. They interpret every move or action of others, and especially those to whom they are responsible, as a move against them. They are, thus, suspicious of the actions and motives of others. These emotional disturbances lead to loss of appetite and insomnia on the part of many workers, and thus to poor health.

Absenteeism and Maladjustment

The worker with a high absentee record is usually maladjusted. A high degree of absenteeism among workers is definitely symptomatic of poor morale, while conversely a low degree would be indicative of good morale. Many factors operate in producing a high degree of absenteeism. A study of these factors will aid in understanding causes of maladjustment, and will provide a basis for the elimination of excessive absenteeism.

An investigation of this problem was made in a machine shop employing several thousand individuals.[4] This study was limited to machine and assembly workers, since absenteeism was higher among these than among clerical and office employees. The plant studied was located in a critical labor area and was operated under the employment stabilization plan. Workers of high skill were used in the shop to turn out precision machine tools, and workers of lesser skill produced finished screw-machine products. The absence rate for the plant ran about 7 per cent, a little above the country's average for machine shops. A representative sample of 550 employees working in eight departments was selected for investigation. The results verified the recurring observation that a small percentage of the employees account for a large share of the total time lost. Forty per cent lost no time in the 11-week period. Of those present, 7 out of every 10 lost only 2 days of working time or less during the period. The critical problem existed in the case of those (approximately 18 per cent) who lost from 2 days out of 11 weeks up to 50 per cent of their scheduled working time. A thorough study was made of the employees who were losing more than the average amount of time. The causes were discovered by interviewing the employees involved and their foremen. The reasons given were listed as follows:[5]

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[4] Jackson, Joseph H., Factors Involved in Absenteeism, *Person. J.*, 1944, 22, 289–295.

1. *Poor work habits* indicated by trouble and fighting with other workers or foremen, tardiness, horseplay, and bad previous work records..........	6%
2. *Personal adjustment,* indicated by separation, divorce, family quarrels, symptoms of psychoneurosis, unstable personal life, drinking, breach of peace, etc....................................	9%
3. *Dissatisfaction with work,* indicated by many transfers, complaints about pay or working conditions, lack of interest or ambition, complaints about the management	16%
4. *Irresponsibility,* indicated by unexplained absenteeism, incapability of being left on own resources, not valuing the job but thinking leisure time more important, no loyalty to the company or job..........................	17%
5. *Outside difficulties,* indicated by outside business or shopping problems, home responsibilities, transportation and housing difficulties, moving, visits to out-of-state homes....................................	17%
6. *Sickness or fatigue,* indicated by evidence of sickness, doctor's or hospital's care, accidents resulting in loss of time, and complaints about health, fatigue, etc....................................	35%

For two-thirds of the employees interviewed, more than one cause was listed. Sickness was the most common cause. Employees in the twenty-six- to thirty-five-year age group had the lowest absence rate. The increased absenteeism of workers over thirty-five was due mainly to the increased sickness rate. The younger employees and the single employees with no dependents (usually the same individuals) had the highest absenteeism rate. Employees who had lived in the community for a long period of time, and those with the best earnings, had the lowest absenteeism rate.

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[5] *Ibid.*, pp. 291–292.

Sickness Rate as an Index

Nineteen firms in Great Britain, employing from 175 to 56,000 workers, supplied information concerning sickness rates for periods of not less than 2 years.[6] Colds and influenze accounted for approximately 30 to 40 per cent of the total sickness loss. Of three groups studied—factory, clerical, and sales—the factory workers tended to have the lowest and the shop assistants the highest rate. Women in all groups had a higher sickness rate than men. The lowest rates occurred in those organizations where the selection of employees is careful, where there are adequate chances of promotion for efficient workers, where members of the medical staff understand the nature of the work to be done and the needs of the workers, where there is stability but not rigidity of organization. Thus the illness index becomes a measure of employee morale. Those who are maladjusted stay away from work wherever they decently can. They need not be considered malingerers when this happens as it is probably literally true that, relative to their better adjusted coworkers, their energies are more depleted by forcing themselves to do that which gives them little pleasure. A high absentee and sickness rate is always suspicious, and frequently yields to other "cures" than medical therapeutics alone.

Physical Disability Resulting from Vocational Maladjustment. Maladjustment traceable to industrial inadequacy may be so severe as to lead to a pathological disintegration of personality. The relationship between mild psychopathic disorder and maladjustment in business activities is shown in the results of the study by Smith and Culpin which was concerned with the susceptibility to telegraphist's cramp of incompetent neurotics in this occupation.[7] The most common symptom of a "cramp" subject is the presence of some rather severe psychoneurotic symptoms related to muscular weaknesses, lack of coordination, or inability. Such individuals are likely to make such statements as "I'll go crazy, if I don't get away from this job." Individuals suffering from this condition may be found in almost any type of business or industrial task. Certainly such individual should not be placed on routine jobs in which there is very little variety. Actually, men have developed insanities because of maladjustments related to their work.

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[6] Smith, May, and Leiper, Margaret, Sickness, Absence, and Labor Wages, *Industr. Hlth. Res. Bd. Rept.*, No. 75, London, 1936.

[7] Smith, M., Culpin, M., and Farmer, G., A Study of Telegraphist's Cramp, *Industr. Fat. Res. Bd. Rept.*, No. 43, London, 1937.

According to the findings of the Industrial Health Research Board, disabled neurotic illness affected a tenth and minor forms of neuroses another fifth of over 3,000 adult workers employed by 13 British light or medium engineering firms during the period 1942–1944.[8] The percentages were higher for women than for men—13.0 compared with 9.1 per cent for the definitely disabled forms and 23 against 19.2 per cent for the minor forms. This was responsible for almost one-third of all absences from work for reasons of illness. The frequency was found to be as high among the skilled workers as among the less skilled, and as high among those in the highest range of earnings as among those earning less.

Workers with domestic responsibilities, those having a wide range of social contacts, and those liking their job had the lowest average of neuroses. Conversely, those having few social contacts, those having unsatisfactory domestic circumstances, and those disliking their work had the highest average of maladjustment. Furthermore, individuals on jobs regarded by them as monotonous, or on jobs requiring sustained attention with little opportunity for initiative and technical responsibility, revealed a high incidence of neurosis.

DISCONTENT AMONG EMPLOYEES

There is usually considerable evidence of discontent among employees prior to the outbreak of some disturbance. This is perhaps most frequently revealed in an uncooperative attitude among the workers with each other as well as with management. It may be manifested in various ways. The workers tend to loaf on the job; they fail to clean up materials properly; there is considerable spoilage and waste; much time is spent in the washroom, and the room is left dirty; supplies are wasted; and in extreme cases, actual sabotage appears. All too often, the first impulse of management is to resort to a "get tough policy." On the surface, this appears at first to achieve the desired results; but such a policy is likely to lead to increased tension. As a result of this, the employees are then in a state of readiness for trouble making. It is under such conditions that calamities often occur.

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[8] Fraser, Russel, *et al.*, The Incidence of Neuroses among Factory Workers, Medical Research Council, *Industr. Hlth. Res. Bd. Rept.*, No. 90, London, 1947.

It has already been pointed out that employees are, because of their concepts of management and attitudes toward supervisors and management in general, in a state of readiness for the development of discontent and dissatisfaction. Where working relations are favorable and working conditions satisfactory, this latent state may remain hidden and become less potent. In such a case, the workers assume a cooperative attitude, and there is an increased efficiency maintained. Those responsible for the supervision of the work of employees should be on guard for signs of emotional dissatisfaction, and when such signs appear, seek the reasons for its presence. When discontent is attacked at its source, there should be an improvement in the attitudes and work patterns of the employees.

BASIC CAUSES OF MALADJUSTMENT

Variables in Adjustment

Scientific research consists essentially in stating as accurately as possible the *relations between variables*. The variables that industrial psychology must analyze, measure, and relate are (1) significant aspects of industrial behavior, and (2) factors conditioning this behavior. Through careful analysis this very general formulation of the problem has been made more specific. Personal and social factors, as well as minute aspects of the physical environment, have to be determined if the causes of industrial behavior are to be understood. Their variety and complexity are observable in the partial list by Hersey[9] of variables that are of interest and significance to both managers and employees. These variables are outlined under the general topics of (1) work, (2) outside influences, and (3) personality factors. The positive and negative influences affecting happiness and adjustment are presented in parallel for contrast and analysis (see Table 14–2).

The study reported by Eckerman[10] dealt with grievances among employees in a large Middle Western manufacturing plant. The personnel records of the plant were in excellent order, and it was from these records that most of the materials for the study were obtained. Seventeen items

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[9] Hersey, R. B., Psychology of Workers, *Person. J.*, 1936, 14, 291–296.

[10] Eckerman, Arthur C., An Analysis of Grievances and Aggrieved Employees in a Machine Shop and Foundry, *J. Appl. Psychol.*, 1948, 32, pp. 255–269. This article is based upon research materials submitted to the faculty of Purdue University as a partial fulfillment of the requirements for the degree of Doctor of Philosophy, under the direction of Joseph Tiffin.

TABLE 14–2. SUMMARY OF VARIABLES RELATED TO THE ADJUSTMENT OF THE WORKER
(A Tinsmith's Case History)

Positive Influences for Happiness	*Periodic Negative Influences*
I. Work	
Had work at regular job (machinist) congenial and stimulating Varied work Called for intelligent thinking He was confident of his capacity, had excellent training and good intelligence His job provided status His relations with his boss helpful Hours and physical conditions of work were satisfactory	Thoughts of insecurity of job Relations with fellows sometimes strained Work unsatisfactory after learning period over, had no feeling of being on his own Tension of work and cramped position No future to it (He was at times required to do different work instead of his regular job)
II. Outside	
Relations with wife satisfactory Pleasure in children and routine of home life	Wife unable to limit expenses to income Too expensive house under purchase Wife's family in better financial condition than he, makes for dissension Lack of sleep and quarrels with wife over performance of household duties after coming of second child Advent of unwanted child Little varied or beneficial recreation
III. Personality Factors	
Abstract qualities of honesty, kindliness, willingness to cooperate, and desire to play fair Very generous and helpful to those he likes Ability to recover quickly from worries	An overbearing manner with fellows accentuated when worried or in a low period A lack of intelligent reasoning based on reality Behavior rather unpredictable Hemorrhoids Great desire to be the center of attraction Willing to do almost anything to hold job

of personal data were available from these records. These data were compared for the machine shop and foundry workers, and for the grievers and nongrievers. Some of the findings thus secured are presented in Table 14–3. There was little difference noted between the grievers and nongrievers in education. More of the machine-shop grievers went beyond the eighth grade in school than was the case for the nongrievers. The foundry grievers were socially more stable than the nongrievers, as indicated by the fact that a larger percentage of them were married. Also, more of them had children. From such studies it appears likely that as the family increases and the needs become greater, the increased financial responsibilities may result in more grievances for the married group than for those with less family responsibilities. This may also be the explanation for the greater number of grievers among workers with credit-standing problems.

TABLE 14-3. PERSONAL DATA OF FOUNDRY AND MACHINE-SHOP EMPLOYEES

Data	Foundry		Machine shop	
	Grievers, per cent	Nongrievers, per cent	Grievers, per cent	Nongrievers, per cent
Schooling:				
8th grade and under	45.7	52.1	25.3	37.0
Over 8th grade	54.3	47.9	74.7	63.0
Marital status:				
Single	6.7	22.4	14.4	23.0
Married	92.4	75.7	82.6	75.0
Children	63.7	46.8	56.7	50.0
Other dependents	13.9	20.4	11.5	9.0
Skill level of employees:				
Skilled	11.7	10.9	27.9	16.0
Semiskilled	67.2	51.2	68.3	65.0
Unskilled	21.1	37.8	3.8	19.0
Credit standing:				
Dun letters	20.2	6.0	4.8	4.0
Garnishments	12.5	5.0	1.0	2.0
Credit store debts	21.1	7.0	4.8	2.0

In the case of the comparisons for the different skill levels, the largest percentage of grievers fell in the semiskilled group. There was no evidence of a preponderance of grievers among the unskilled, but rather that a larger percentage of nongrievers were found in this group. Some further conclusions brought forth from this study are:[11]

a. The most frequent grievances are filed for pay and wages (30%), the next largest group of grievances concern jobs and work (28%), with grievances concerning seniority coming third (10%).

b. Union officials filed the highest per cent of grievances on matters of jobs and work; union members filed the highest per cent of grievances on seniority and pay and wages. The majority of grievances filed did not refer to the contract in any respect; of those which did refer to the contract, union members and not officials were the more numerous. However, in these items concerning grievances the differences were not significant enough to warrant any conclusion.

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[11] *Ibid.,* p. 269. Reprinted by permission of the *Journal* and of the American Psychological Association.

THE JOB AND MALADJUSTMENT

Two principle sources of employee dissatisfaction on the job may be listed: (1) the policies and general practices of the company—often dictated by top management; and (2) the personalities of foremen and supervisors with whom workers are associated. In the larger concerns, workers do not come face to face with the top executives. Their contact with these executives may be thought of as an indirect one—through the policies and practices they initiate. It is in this manner that these people exert a powerful influence upon the development of satisfaction and dissatisfaction among workers. Through the policies and practices of a concern the organization as a whole reflects the personalities responsible for them. These, in turn, determine in a large measure whether or not the company is a pleasant or an unpleasant one for which to work.

The place and the influence of the foremen in promoting morale was discussed in Chap. 13. The face-to-face relations of employees and the foreman makes his position important relative to the attitudes and satisfactions of the workers. It is, therefore, essential for this relationship to be one of friendliness, fairness, and respect for the rights and feelings of each other. Otherwise, unfavorable attitudes and job dissatisfaction will characterize most of the workers.

Income and Dissatisfaction. It was pointed out in Chap. 2 that there are a number of psychological motives affecting the worker's attitude toward the job that may be more important in producing good morale than wage incentives. It appears, however, that job dissatisfaction is usually caused by a multiplicity of factors. Because of this, it is very difficult to classify the causes of dissatisfaction towards one's job. These factors often interact upon each other and in so doing accentuate the total effect.

A national representative sampling of the adult population eighteen years of age and older was studied by Centers and Cantril[12] to determine the factors related to one's present satisfaction and aspiration with respect to income. It was found from this study that over one-half the population is dissatisfied with its present income. The materials presented in Table

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[12] Centers, Richard, and Cantril, Hadley, Income Satisfaction and Income Aspiration, *J. Abnorm. and Soc. Psychol.*, 1946, 41, 64–69.

14–4 reveal that the higher the person's income the more likely he is to be satisfied with his work. This problem, then, is closely related to income in relation to adjustment, which will be discussed further at a later point in this chapter.

TABLE 14–4. INCOME SATISFACTION AND INCOME ASPIRATION

Weekly income	Cases	Dissatisfied, per cent	Satisfied, per cent	No opinion, per cent
National	1,165	56	32	12
Under $20	163	68	16	16
$20–$29.99	170	72	19	9
30–39.99	207	67	20	13
40–59.99	310	54	35	11
60–99.99	191	43	49	8
100 and over	124	20	66	14

* By permission of the *J. Abnorm. and Soc. Psychol.* and the American Psychological Association.

Insecurity and Maladjustments. Anything which seems to threaten the security or status of the employee tends to excite fear. This is truer today with our highly specialized technological life than ever before. The average worker has little recourse in case his security is lost. He no longer owns a small farm to which he can turn or has a special trade that he can follow. The average worker owns very few tools but depends upon those supplied to him on the job. His only marketable commodity is whatever skill he may have developed in some special direction as a result of his experience. Robert McMurry[13] says of this:

> He is, therefore, much more dependent economically upon his job tenure than was the case with the man who could, if necessary, set up in business for himself. In addition the longer he remains with a particular company, often the greater his difficulty in getting work elsewhere. This is because the bulk of the routine jobs in industry today . . . do not require great skill; certainly not in the sense of the old time craftsman. Consequently, the employee who has spent ten to twenty-five years in a particular line of work has gained little that is saleable, but has lost his youth, his vigor, and his adaptability to new lines of endeavor.

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[13] McMurry, Robert N., The Problem of Resistance to Change in Industry, *J. Appl. Psychol.*, 1947, **31**, 589–593. Reprinted by permission of the *Journal* and of the American Psychological Association.

It is but natural, then, that industry would find among the employees a great resistance to change. This resistance carries over and oftentimes operates in cases where the change would be highly beneficial to the employees. This opposition to change may become sufficiently bitter that the workers will resort to deception, work stoppage, and outright sabotage. It is not implied here that these fears are all ill-founded, for workers can recite cases where the introduction of new machinery has deprived many of their fellow workers of jobs or, in other instances, has increased their load and difficulty.

In order to combat this fear, management should first of all assure workers that their own security will not be jeopardized by the change. If there is a record of change, this record may be overcome if the employees are assured of protection of their interests. Such an assurance becomes highly potent as a force for alleviating fears. Another principle which should be followed is that of introducing changes in a gradual manner. If workers are informed in advance of minor changes to be made, their apprehensions will be lessened considerably. While most industrial concerns rely on their foremen to improve communications with the workers, many have found union officers and stewards helpful in passing information along, and in dispelling rumors and anxieties. A good example of down-the-line communication occurred in a textile company which proposed to install new machinery that would replace 130 skilled personnel.

> The management knew that it would take a year to secure delivery of all the machines, but just as soon as they were ordered the union officers were called in and given the complete details, including delivery dates, number of people involved, and the promise that the seniority of those replaced would be protected. As the machines arrived, each worker in seniority order was to be given her choice of any existing openings; or she would keep her old job and wait until a suitable one did appear. The union passed the word along, and the company also called workers and stewards together for conferences on the subject. Result: all transfers completed to everyone's satisfaction.[14]

Occupational Level and Maladjustments. The results of a survey conducted by *Fortune* magazine furnish some valuable information bearing on the problem of the relationship between maladjustments and occupational level.[15] Job-satisfaction feelings of workers were secured, based on a sampling from the various occupational levels. In this survey it was found that most Americans of the executive and professional class appear to find satisfaction in their work. This is only true, according to the survey, for approximately one-half of the factory workers and union members. This is shown in Table 14–5 which gives the replies of the different occupational groups to questions dealing with their interest in and enjoyment of their work.

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[14] The Management of Men, reprinted from *Fortune* magazine, February, 1949, pp. 104–156. Copyright Time, Inc.

TABLE 14–5

Question: On the whole would you say that your job is really interesting and enjoyable, or would you say that it is all right but not very interesting, or would you say that it is dull and boring?

Answer	Total, per cent	Professional and executives, per cent	Salaried employees, per cent	Factory workers, per cent	Union members, per cent
Interesting	69.1	92.4	71.7	54.1	52.6
All right	22.6	6.2	23.7	30.5	34.1
Dull	7.2	1.0	4.6	14.5	12.7
Don't know	1.1	0.4	....	0.9	0.6

A further analysis of the results shows that in addition to the differences in the feelings toward their work by the different occupational groups, advancement possibilities are important: 77 per cent of those who believed their opportunities for advancement to be good enjoyed their work, as compared with 60 per cent of those who saw little chance of such advancement. The conclusions of the survey do not present an overly enthusiastic forecast for the future of good industrial relations.[16]

Those who are the most pessimistic about their personal futures and the least interested in their jobs are to be found in the greatest numbers in two overlapping groups—factory workers and union members. It is anything but a new thought that mass-production methods tend to cause individual frustration and to smother ambition. It has also been argued that the paternalism of unions toward their members acts to minimize the initiative of workers, causing them to feel that their reward will be the same whether they work hard or loaf. The Survey figures show that there is a tendency among factory workers and union members to believe there is little they can do to better themselves. It may be time, therefore, to give more thought to what mass production is doing to the people it is supposed to serve. Is the worker beginning to feel that he is somewhat trapped between impersonal mass production and the paternalism of big unions?

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[15] The Fortune Survey. Table 14–5 is reprinted by permission of the *Fortune* magazine, January, 1947, pp. 5–6, 10, 112. Copyright Time, Inc.

[16] *Ibid.*, p. 5.

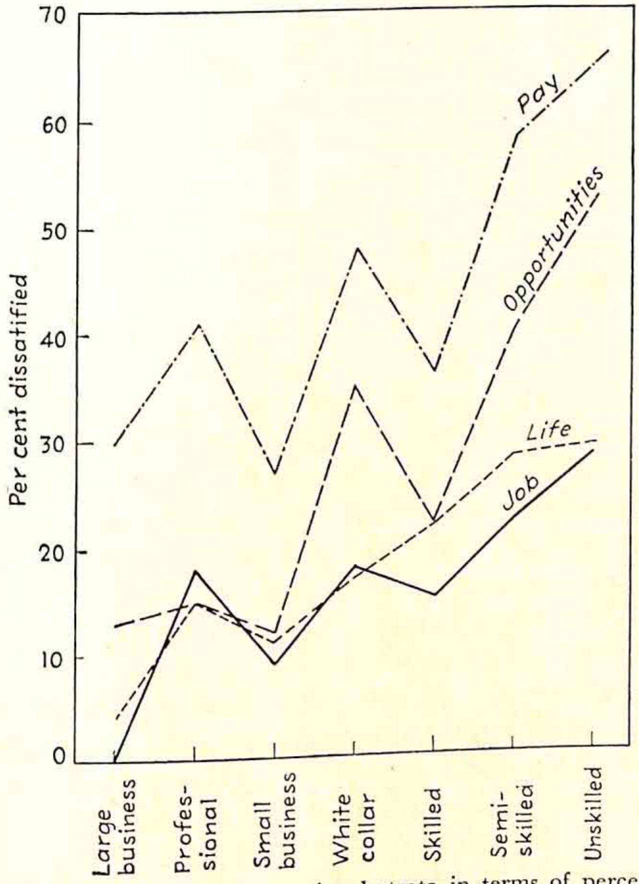

FIG. 14–2. Comparison of urban occupational strata in terms of percentages of persons in each stratum who are dissatisfied with their jobs, pay, opportunities, and chances to enjoy life.

In the study by Centers, referred to in Chap. 13, a national cross section of the adult white male population was interviewed regarding personal satisfactions and frustrations, aspirations, values, and other matters relating to their attitudes toward occupational groups, occupational opportunities, etc.[17] An analysis of the data gathered reveal significant differences in satisfaction and dissatisfaction among occupational groups with respect to the various matters studied.

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[17] Centers, Richard, Motivational Aspects of Occupational Stratification, *J. Soc. Psychol.*, 1948, 28, 187–217.

The patternings of these differences furnishes additional information about the factors related to dissatisfaction and tension. Figure 14–2 gives a graphic illustration of this. Centers points out: "If a given occupational stratum shows many dissatisfied people in some one respect, the same stratum shows them dissatisfied in other respects also." It is perhaps to be expected that the large business group would show least dissatisfaction on each of the issues, while the subordinate groups represented by the white-collar workers, semiskilled workers, and unskilled workers manifest consistently the greatest dissatisfaction. It is between these groups that industrial strife has raged most intensely during the past decade. The fact that those groups in subordinate social and occupational positions are dissatisfied with their lot in life is a sufficient explanation for their demands and activities within recent years.

According to the Fortune Survey of workers relative to the problem of who liked his type of work,[18] 83 per cent are loyal to their company in attitude; while of these disliking their type of work, only 69 per cent regard their company as a good place to work. "Factory people who are both satisfied with their firms and satisfied with their kind of work can be called 'ideally adjusted' but they amount to only 26 per cent of the working force. By the same token those who are satisfied with neither their company nor their work represent only 12 per cent and are so called 'miserably adjusted.'" Thus, there are 62 per cent who have mixed feelings, and it is this large group in particular that management should be concerned about.

HOME AND COMMUNITY FACTORS

Unfavorable Home Conditions. Domestic strife is one of the most common factors outside the working environment that contributes to maladjustment. The worker who is unhappy in his home life is all too likely to develop habits of living or attitudes that do not promote good working habits and relations. Some home conditions which should be considered in an attempt to arrive at conditions responsible for the maladjustment may be listed as follows:

1. Are there evidences of conflicts between the husband and wife?
2. Are there conditions in the home that place a severe emotional strain

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[18] Reprinted from *Fortune* magazine, June, 1947, p. 5. Copyright Time, Inc.

upon the employee (for example, chronic illness, in-law problems, financial strain due to debts, or certain financial obligations, etc.)?

3. Are there evidences of emotional conflicts between the worker and other members of the family?

4. Does he show any special frustration in his life resulting from inadequacies or special conditions in his home life.

5. Are there any particular problems at his home which provide a source of constant tension and anxiety (for example, a delinquent son or daughter, prolonged illness, etc.)?

Undesirable or Inadequate Social and Recreational Contacts. Certain community forces or conditions may be an important factor contributing to the maladjustment of a worker. The writer is acquainted with an employee in a textile factory who became so imbued with a religious fanaticism sweeping his community that his effectiveness as a worker was seriously impaired. Again, there is the possibility of neighborhood strife, a pattern of excessive drinking or gambling among the members of the community with which the individual is associated, or some other activity that may contribute to maladjustment. It is not implied here, however, that community activities tend to promote maladjustment. More often, a reasonable amount of such activities will tend to enhance the worker's feelings of well-being and satisfy a need for belongingness. These tend to promote adjustment and satisfaction on the job.

Wholesome recreational activities pursued during leisure time will contribute much toward making him a happy worker, and a happy worker is more likely to be an adjusted worker than is an unhappy worker. It makes a great deal of difference whether the worker spends his Christmas vacation with his family visiting some friends in the country, or engages in a wild gambling spree including considerable drinking of alcoholic beverages. In many cases, industry recognizes the values to be derived from desirable recreational pursuits and provides recreational centers, picnic grounds, community houses, and the like for employees. When these are provided and maintained sincerely in the interests of the welfare and happiness of employees, substantial returns in the form of better adjusted and more efficient workers will result.

PERSONALITY FACTORS

The importance of personality factors in satisfaction and adjustment is recognized by foremen and supervisors who have a good understanding of human nature; however, scientific data showing such a relationship may not always be available. This was recognized by Oakley[19] a number of years ago when he stated:

> Some persons do appear to be more prone to psychoneurosis than are others. They would form obsessions in almost any workshop or office. There are, however, situations which seem to be particularly unsuitable. Some of these situations vary with each person according to his abilities and other temperamental qualities. Others should be avoided by all persons prone to psychoneurosis. . . . Work requiring continuous intense concentration is likely to lead to disturbances, and bullying foremen can bring serious harm to workers in their charge. The person with psychoneurotic tendencies is less likely to be successful in team-work than in individualistic work. He might seek the security of a groove, but he would resent its restraints.

Conflicts between Motives. Three types of conflicts between motives have been presented by Lewin.[20] The first type occurs when an individual is faced with two positive forces (referred to by Lewin as valences). For example, if the employees of a concern are offered the choice between a certain wage increase and 2 weeks' vacation with pay, they are faced with a choice between two desired goals. The choice finally made will be the one that offers the greatest satisfaction. This does not mean that it is the most desirable goal as viewed by the economist or by the social worker. Also, the same choice might not be made by another group of employees. When the two forces are of approximately the same strength, the intensity of the conflict is increased. Sometimes these may be so nearly equal that an individual is unable to choose, and vacillates from one to another. He may then resort to "flipping a coin" to arrive at a decision.

The second type of conflict given by Lewin occurs when the individual is faced with one of two negative forces or incentives, and the possibility of avoiding one of them is well-nigh impossible. This is illustrated graphically in Fig. 14–3. The worker in this figure is faced with two negative conditions: (1) threat of losing his present job, or (2) change to another job more disagreeable in nature but where there is a greater need for workers.

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[19] Oakley, C. A., The Industrial Misfit, *Hum. Factor*, 1934, 8, pp. 129–130. This quotation from an English industrial psychologist may not be couched in the language an American psychologist would use, but the meaning is clear and would be the same for the two.

[20] Lewin, K., *Dynamic Theory of Personality*, p. 123, McGraw-Hill Book Company, Inc., New York, 1935.

A third type of conflict results when a positive and a negative force are associated with the activity. This may be illustrated by a worker who is offered a substantial increase in rate of pay, but the new assignment involves more health hazards. This condition prevailed in connection with many of the promotions in the military services during the Second World War. Men were recruited for certain hazardous assignments by increased monetary and promotion-in-rank incentives. It might be stated as a general principle that anyone can be induced to choose an unpleasant incentive provided the pleasant and satisfying incentives associated with it outweigh the unpleasant feature. This balanced condition will vary with different individuals. To some individuals, a promotion in title may in itself be sufficient to offset extra responsibilities and time on the job that may be associated with the new title. This problem is closely related to that of an individual's aspirations and values referred to later in this chapter.

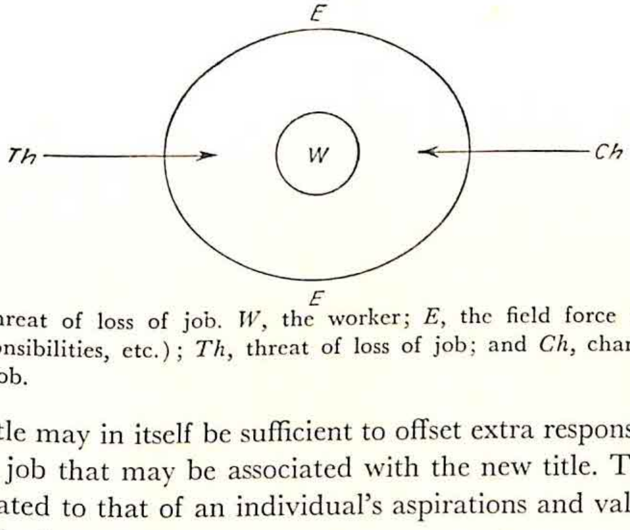

FIG. 14–3. Threat of loss of job. *W*, the worker; *E*, the field force (environment, prestige, responsibilities, etc.); *Th*, threat of loss of job; and *Ch*, change to a more disagreeable job.

Level of Aspiration. An individual's success or failure may be evaluated in terms of his level of aspiration, especially when this is considered in the light of satisfaction and adjustment which result from attaining one's goals or in light of frustration resulting from the failure to attain them. Concerning the complete attainment of one's goal, Maier[21] has stated:

> The level of aspiration functions as a regulator of success and failure and serves to protect the ego from frustration, while, at the same time, it keeps the goal ahead of actual achievement. Under conditions of normal and healthy functioning, a person never achieves his goal because the

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[21] Maier, R. F., *Psychology in Industry,* p. 245, Houghton Mifflin Company, Boston, 1946.

aspired goal moves ahead as it is approached. This permits the person to continue to exert effort.

The study by Sears was conducted with fourth-, fifth-, and sixth-grade pupils as subjects. Their levels of aspiration in reading and arithmetic were studied in relation to academic success. The discrepancy score was the chief measure of the relation between the level of aspiration and performance. This score is the difference between the performance time of a given trial and the level of aspiration set for the succeeding trial. The results revealed that "successful children react to the level of aspiration situation in a similar way, whereas unsuccessful children, lacking in confidence, may adopt one of a number of different behavior techniques in this situation."[22]

Sears[23] postulates that "in individuals of average endowment, the normal adjustive reaction to cultural demands and pressures in our competitive society somewhat resembles the following sequence. There is a placement of goals a short distance above the observed performance, followed by activity strongly directed toward these goals. If a goal is attained, a new one is set slightly higher, and the process repeated. If, on the other hand, the goal is not attained after a reasonable length of time, its position will be adjusted downward and the activity directed toward the new goal."

If the individual is unable to achieve a goal that compares favorably with others, or if the goal set is below the average, he may resort to setting a still higher goal. This creates a greater discrepancy score but may provide a sort of satisfaction. The cultural norms, in terms of competition and standards, are important factors determining the level of aspiration, and this may be considerably out of line with performance. This will be reflected in a high discrepancy score and accompanied by frustrations.

The study by Gould[24] of the aspiration level of 82 male college students showed that success and failure were not defined in the same manner by all the students. Some students regarded these as absolute while others looked upon them as relative. To some students perfection or attaining one's goal was not essential for a feeling of success. A pronounced disparity between estimate (aspiration) and performance was not always regarded by the subject in terms of failure or success, but it was sometimes an incentive for increased effort. This was one of the clearest differences between the high and the low groups. For the high group such a disparity was oftentimes an incentive, while for the low group this discrepancy was a strong indication of failure. Several observed forms of reaction to failure, as presented by Gould, are applicable to industrial tasks, and they are included in this discussion: (1) trying to improve the performance; (2) becoming discouraged and giving up further attempts; (3) presenting excuses for the failure (a form of rationalization); and (4) a combination of these procedures.

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[22] Sears, Pauline S., Levels of Aspirations in Academically Successful and Unsuccessful Children, *J. Abnorm. Soc. Psychol.*, 1940, 35, 498–536. Reprinted by permission of the *Journal* and of the American Psychological Association.

[23] *Ibid.*, p. 529.

[24] Gould, R., An Experimental Analysis of Level of Aspiration, *Genet. Psychol. Monogr.* 1939, **21**, 115.

Employee Anxiety and Frustration. The problem of aspirational level is closely related to anxiety over class status. Considerable personal maladjustment may appear as a result of the employee's striving to attain class status out of harmony with his vocational abilities and possibilities.

Furthermore, there is likely to be much job dissatisfaction and a high rate of labor turnover among workers in positions below their vocational and aspirational level. It is important, therefore, for the personnel office to recognize this fact in the selection and training of employees. There are many individuals whose vocational abilities are above their aspirational level. Teachers have constantly observed this among children from the lower occupational groups. The socio-cultural environment of these children has not provided the necessary stimulation for them to desire to move into a higher socio-occupational group, and psychologically these individuals may be considered well-adjusted in their social and vocational life activities.

The absence of class anxiety is often regarded by teachers and others as an indication of maladjustment. (This may be interpreted as due to their concept of adjustment.) However, the worker who is not afflicted with class anxiety and is satisfied with his occupational status may reveal a higher degree of job satisfaction and less job mobility than the worker who is striving to reach a higher round on the occupational scale. Max Levin[25] has discussed this in relation to counseling. He states:

> The recognition of status anxiety as a potential determinant of occupational choice should lead to a fuller understanding and appreciation of the

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[25] Levin, Max M., Status Anxiety and Occupational Choice, *Educ. and Psychol. Meas.*, Spring, 1949, p. 36.

ego-involvement with occupational achievement so widespread in our culture. It will clarify in part the painful strivings of some clients, the indecision of others, and the difficulty evidenced in some cases to arrive at an occupational choice commensurate with and appropriate to their basic personal characteristics.

When an individual is frustrated or emotionally blocked, he seeks an outlet for his tension. This outlet may take many forms; the important thing to bear in mind is that a release from this tension is not only necessary but highly desirable. F. C. Smith[26] presents a case, occurring between a foreman and one of his men, which illustrates frustration and a need for tension release.

> . . . These two men, both being oldtimers with the company, had a rather violent argument over a little matter of no real importance and, as such things go, bitter words were exchanged. The next day the worker reported in an intoxicated condition. He had always been a reliable man and although he sometimes drank he was not an alcoholic. This was the first time he had ever been intoxicated on the job. The foreman having been this man's friend for many years did not report him; instead he let him "sleep it off."
>
> During the several following days the foreman did not mention the incident to the workman, treating him exactly as though nothing had occurred. The worker reacted to this by attacking several other men in the department, somewhat to their astonishment, and by "blowing up" several times over trivialities. Later, the worker admitted to several men that he had been wrong in the argument which he had with the foreman.
>
> Instead of discussing the reasons for the workman's behavior let us take a look at his thinking. Realizing that he had been wrong in the argument he felt ashamed, guilty and resentful, and since these are uncomfortable emotions even though they are often self-induced, they were a little more than he could absorb. As a result his resentment was directed toward that individual who, he felt, was responsible: the foreman. Illogically enough (and we must remember that human beings are not logical, but psychological) and at the risk of losing his job he "attacked" his foreman by getting intoxicated at work, saying in effect: "To hell with you! You may think I owe you something and have to produce for you just because you are my boss. But I don't. I'm independent."

Health. The so-called misfit may result from some failure in the original selection, from an inadequate or incorrect training program for new workers, from factors or conditions in the working environment, from some disturbing forces outside the working environment, or from personal or constitutional factors present in the worker. Case studies of seriously maladjusted workers show that neuroses are present in a large percentage of the cases. The basic etiology behind an industrial neurosis is obviously little different from that involved in any neurotic disorder. Both in the general and in the particular case, the individual finds himself unable to solve some problem in accordance with acceptable social criteria or seems to be unable to extricate himself from difficult problems or conditions which confront him. Some solution, however, is generally reached; the difficulty with the solution arrived at by the neurotic is that it is either not in accord with the structure of reality or is unacceptable to the group with which he is identified.

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[26] Smith, F. C., The Real Reason for Grievances, *Person. J.*, 1948, 26, 252–255.

In a large percentage of cases, there appear both physical and mental factors. These are so mutually interrelated that one is unable to draw a line of separation between them. Thus, these should not be regarded as separate forces and conditions. General health states leading to nervous strain may be an important source of maladjustments. Concerning these conditions, a number of years ago Oakley[27] pointed out the following:

> One of the strongest arguments against the speeding-up of the workers, which is undoubtedly obtainable in some cases by a skillful use of financial incentives, is that its ultimate effect upon the workers is harmful. Collapse often follows months or years of record-breaking, and extreme efficiency might be replaced by extreme inefficiency. Physical exhaustion is certainly a contributing factor in these upheavals. Psychological factors also play a part, and the persons who are most readily induced to work "full out" are, perhaps, persons who are likely to become psychoneurotic. On the other hand, allowance must be made for the tendency of psychoneurosis to increase the apparent liability to fatigue, so that some persons actually feel tired before they have done any work at all.

MALADJUSTMENTS PECULIAR TO WOMEN

As may be gathered from the viewpoint stressed in previous chapters, occupational influences never act alone, but rather in connection with other factors in the total life situation. The place of women in industrial activities is never fixed, but constantly in a state of flux, depending upon such factors as traditions, religious practices, economic conditions, national problems, and the like. When the Hitler regime came to power in Germany, women were dismissed from business in great numbers as a means of alleviating male unemployment, but as soon as the rearmament program led to a labor shortage, they were called back to do longer, harder, and more varied work than ever before. This partial emancipation of women from a purely domestic life throughout our industrialized society has resulted in the creation, for them, of a topsy-turvy sort of world. Many men living today have seen the shift in the status of women from that of a domestic servant, or keeper of the home and garden, to a ruthless competitor in the fields of industry, business, and the professions. The approximate economic equality among the sexes which now exists has brought about great positive as well as negative reactions among women.

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[27] Oakley, *op. cit.*, p. 129.

Personality studies of women engaged at some bread-earning task reveal the influence of certain forces not present to any extent among men. Greater emotional instability, a less objective viewpoint, exaggerated precisions, sensitiveness, patronizing attitudes, exclusively subjective judgments (all of which affect one's relations toward the outer world) appear to be more in evidence among women workers than among men.[28] With many women the choice of home or career occupies the center of the emotional stage. Frequently the choice lies between a home with children and the sacrifice of certain features of life very much desired and a home without children but with the ability to possess those cherished things. Even though these choices are not always made consciously, they invariably have an important influence and are significant in developing the mature personality pattern. A man in business can set his goal and plan procedures for reaching it to a much greater degree of accuracy than the typical woman can. He is better able to continue to grow and expand in an effort to reach the prize. His basic occupational plan is less likely to be interrupted by marriage, which to him is an incident—an important one, to be sure—but not the crowning event of life as it is to most women. When the career for female workers is not thus "interrupted," it frequently brings disappointment or a distorted personality due to strong conflicting desires. Under existing conditions, only exceptionally able or fortunate women are able to blend these rival values into a harmonious whole.

But it must not be inferred from this discussion that emotional disturbances are peculiar to women. It is the unstable position of women in the industrial order and their greater exposure to intensely conflicting goals that are chiefly responsible for the greater incidence of frustration among mature women workers than among their male colleagues.

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[28] Saunders, Elinor B., Emotional Handicaps of Professional Women, *Ment. Hyg.*, 1929, 13, 45. Note that this is a woman's judgment upon her own sex.

TREATMENT OF MALADJUSTMENTS

The provision for handling individual problems and grievances is most important, for if these are cared for in their early stages no ill feelings, rumors, and misunderstandings will accumulate. It is, furthermore, most important that some procedure be set forth for handling grievances, so organized that those down the line closest to the workers would be able to settle them. W. R. Burrows, vice-president in charge of manufacturing, General Electric Company,[29] points out that 95 per cent of all grievances at the General Electric Company are ironed out by the foreman. However, it is important that there be a way for the worker to make known his grievances to those in more responsible positions. The employee should know how this can be done without jeojardizing his position in the company.

IMPORTANCE OF EARLY DETECTION

The correction of maladjusted work patterns should be begun as early as possible, but there is no sound reason why it should not be a continuing effort applied wherever the occasion permits. A splendid illustration of successful job adjustment may be seen in the following episode presented by William Seabrook.[30] An accountant in a large manufacturing company was well on the road to dismissal. The head of the department in which he was employed described him as capable but not interested in his work. While being tested at the Human Engineering Laboratory at Stevens Institute of Technology, he expressed a distinct dislike for accounting. Following the suggestions set forth by O'Connor of the laboratory, he was shifted to cost accounting, which required work with blueprints and graphs, *i.e.*, equipment similar to that found in certain types of engineering. Here the accountant was able to make use of abilities along the line of his interests and preference. After 4 years at this work, he was advanced to the head of the cost accounting department, and at a later date, he became chief of a larger division. The possibilities of thus converting actual or incipient cases of maladjusted individuals into efficient workers are too numerous to be ignored by any alert personnel or management office. An unremitting search for the interests and likes of workers at all times should be carried on by those in charge of personnel activities and problems. An understanding of symptoms of maladjustment will enable industry to locate those workers in need of special attention.

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[29] Burrows, William R., Management in Evolution, *Survey Graphic*, 1941, **30**, 594.

[30] Seabrook, William, They Find Out What You're Fit For, *The Forum*, August, 1938.

It was suggested earlier in this chapter that absenteeism may be an index to maladjustments. Many companies realize this and keep individual records of absenteeisms and their causes. A study of the practices of 141 companies in the metropolitan area of New York showed that 97 per cent of the companies surveyed maintained attendance records.[31] Most of these maintained a record for each employee. Of these, 134 companies informed their people that attendance records were kept, while one company did not. Individual attendance records are helpful to the company in maintaining policies and understanding with workers, provided they are kept and used for the benefit of all concerned.

Although most companies claim that the top executives are ever ready to hear the complaints of employees, there are a number of barriers that tend to close the door to the typical employee. In the first place, the office arrangement is usually not conducive to inviting the worker to reveal his problems and difficulties. The large desk that often separates the employee from the manager or supervisor, the arrangement of the furniture in the office, the presence of secretaries, and the general formality of the surroundings make the worker hesitate to bring his complaint to the top executive.

Second, the worker may fear, and in some cases rightly so, the attitude and actions of his foreman or supervisor in case he carries his complaint to the top executive. Especially would this be true when his immediate supervisor himself is the major subject of the complaint. Realizing the dangers and difficulties that may be encountered from such an action, he decides to "grin and bear his trouble." A third factor which cannot be overlooked is the fact that so often the top executive is a polite and courteous listener but does nothing to correct the abuse, even when it seems to be a real basis for a complaint. Once such a general rumor about the executive appears among the workers, few are interested in taking the trouble and endangering their security by going to him to discuss their problems. The result: emotional tension and lowered morale.

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[31] What 141 Companies Do about Lateness and Absenteeism, report of a survey of the New York Personnel Management Association, *Person. J.*, 1950, 29, 142–154.

NEED FOR OUTLET FOR EMOTIONAL TENSION

The emotional tension among employees oftentimes remains pent up, due to the lack of a suitable outlet. The structure of industrial concerns has been patterned after that found in practically all our old established institutions (the military, the church, the older political states, and the family of early days in America). The autocratic or military framework is such that all authority and power flows from the top downward.[32] Such a pyramid of authority carries with it a form of suppression of expression and initiative and leaves those at the bottom in a state of subjugation. That there is a need for an outlet for the tension of those at the bottom has been recognized by able leaders throughout the centuries. The totalitarian leaders at all periods have attempted to provide scapegoats—usually minorities that were oftentimes helpless when thrust into the clutches of the larger group. Since our modern industrial concerns are usually unable to provide scapegoats, they are often faced with a large group of dissatisfied workers.

In an effort to eliminate widespread dissatisfaction, management has often provided improved working conditions and intelligent and sympathetic supervision. Many workers, however, feel the need for participating in some manner in decision making where their welfare is directly involved. Many companies have taken the attitude that this is a problem for management and not for workers to be concerned about. Other companies have tried various procedures for increasing participation on the part of the workers in policy making. There is good evidence that this increased participation has produced an outlet for employee tension and dissatisfaction and led to an improved morale among the workers.

NEED FOR COUNSELING

The employee is often beset with difficult problems. However, he is often unable to find a suitable outlet for tension created as a result of problems met on the job. As already discussed, he is sometimes faced with difficult problems connected with his home or social life, and his success in meeting these problems will be reflected in his attitude toward his work. Furthermore, it has been found from an analysis of 80 cases that early family experiences are definitely related to the ways an individual reacts toward his job.[33] Thus, a knowledge of an individual's background and present status will provide a trained and sympathetic counselor with valuable information with which to assist the individual in the solution of his problems. The case of Jim is an illustration of the use of such information.

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[32] These statements are not intended to imply that all concerns are organized and operated in an autocratic manner. There are many concerns, both large and small, that are conducting some interesting and farreaching experiments in democratic practices. See Harbison, F., *Patterns of Union-Management Relations,* Science Research Associates, 1947; *Partners in Production,* American Book-Stratford Press, New York, 1949.

Jim had come to New Britain, Connecticut, from a small town in Oklahoma to work in a defense plant during The Second World War. He was considered a good and dependable worker. The personnel manager was, therefore, surprised when one morning the supervisor of the department in which Jim was employed asked him to come into a certain division of the plant and discuss with him his recent conduct.

The personnel manager looked up Jim's record and noticed that he had been employed for a little more than 5 months. During this time, his attitudes had been rated as excellent. The question in his mind was: What has happened to Jim? After consulting Jim's supervisor, he learned that on the previous day (Monday) Jim had scared a girl by a threat to tie a rope around her neck. Also, during a scuffle on the same day, he broke the wristwatch of a friend. When approached by the supervisor, he was in a bad frame of mind and used some rather violent language. The personnel manager remembered Jim as a courteous, fairly intelligent, rural-minded boy from Oklahoma, nineteen years of age. He approached Jim, then at work, in a calm manner. After talking with him about his work and trying to offer a word of encouragement, he asked him about the trouble yesterday. Jim, in a rather repentant mood, broke down and related some conditions and happenings in his life during the past 5 or 6 months. Jim had been very lonely in his new environment. To add to this state, he had just received a letter from his girl friend in Oklahoma in which she said she was passing him (Jim) up for another boy she had recently met. Jim thus came to work in an emotionally tense condition, and this tension found release when the girl crossed up with him, and again when a friend of his on the job tried to talk with him.

The Hawthorne Plan of Personnel Counseling furnishes a most effective means for relieving workers of considerable tension and helping them with their personal problems. This program grew out of trial experiences of interviewing employees during the years 1928 to 1931. The program is set up in a company's industrial relations branch as a service to the employees and supervisors. Both men and women counselors are employed, the men being assigned groups of men to counsel, while the women are assigned groups of women. The program has been described by Dickson[34] as follows:

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[33] Friend, Jeanette G., Work Adjustment in Relation to Family Background, *J. Soc. Casework,* 1948, 29, 89–93.

> Every counselor is assigned a territory comprising some 300 employees and his entire time is devoted to rendering a counseling service to them. The counselor does not have any other duties or responsibilities. Each counselor has access to the shops and office locations to which he is assigned and spends a considerable part of each day contacting people while they are at work. This enables them to meet newcomers and to keep in touch with employees whom they have already interviewed.
>
> Their contacts with employees are of two kinds: off-the-job interviews and on-the-job contacts. The off-the-job interviews are held in an interviewing room where the employee may talk in privacy. Employees may be interviewed as often as seems necessary and there is no time limit to the interviews. In practice the average around an hour and twenty minutes. The on-the-job contacts take place at the employee's work place, in the aisle, at the drinking fountain or in the rest room. It is largely through these contacts that our counselors keep in touch with the employees and integrate themselves in the work groups.
>
> As we are organized, interviews may be initiated by the counselor, by the supervisor, or by the employee. In all cases permission of the supervisor is obtained before the employee is taken off the job. Average earnings are paid for the time spent with the counselors and the interviews are held confidential.

EMPLOYEES' MENTAL HYGIENE

There is considerable evidence that a large percentage of time lost from work is due fundamentally to neuroses,, *i.e.*, emotional or mental illness of one kind or another. On the basis of her experience as a psychiatrist with the Metropolitan Life Insurance Company, Giberson[35] concludes that the production of an individual is in a large measure the result of his mental contentment and security. The fact that psychiatric treatment brought a number of poor producers back to a satisfactory level of production is good evidence that maladjustments among workers are closely related to poor or unsatisfactory levels of production. Many workers, possibly all, would benefit from occasional consultation with guidance counselors. There is no surer way of discovering and treating minor problems and symptoms of maladjustment before they develop into full-fledged problems. Many companies recognize this and employ counselors specially trained in methods and procedures for dealing with workers who are faced with difficult problems.

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[34] Dickson, W. J., The Hawthorne Plan of Personnel Counseling, *Amer. J. Orthopsychiat.*, April, 1945.

[35] Giberson, L. G., Nervous Health in Industry, *Person. J.*, 1937, 15, 255–259.

The advent of the testing movement brought with it an emphasis on objectivity. Tests were developed to aid counselors in detecting the problems of workers. In many cases, counselors were inclined to look upon these instruments as the final answer for determining those workers suffering from maladjustments and facing special problems in their daily lives. Most of the studies conducted in an effort to determine the validity of such tests show that in most cases their values are quite limited. This does not mean that they have no value; however, such tests in the hands of a counselor who does not understand their limitations as well as their possibilities are likely to be more harmful than beneficial. Perhaps the best basis for advising with the worker is information obtained from a case history collected over a long period of time. Even here, one must interpret various happenings in the life of the person concerned in terms of all the conditions and forces operating upon him at that time. The fundamental needs of the worker, discussed in Chapter 13, must be kept in mind by the counselor at all times. This will enable him to understand better the actions and problems of the worker.

Many counselors make another mistake by attempting to solve the worker's problems for him. This cannot be done. The counselor can only guide and motivate the worker in his efforts to satisfactorily solve his problems. In order to do this the counselor must have information about the worker—his needs, aspirations, abilities, and limitations. It is in this connection that tests may be of value if correctly interpreted and properly used. Just as no tool is better than the worker using it, so no personality test is any better than the person making use of results obtained from it. Perhaps it may be truthfully stated that all people have difficult problems at times in their lives; the industrial employee is no exception to this. The help of a trained counselor who understands the problem of the worker, who understands his background and needs, and who has the character qualities that assure him the confidence of the workers will be invaluable to industry and provide for increased happiness and satisfaction among the employees.

Industrial Psychotherapy—Goals and Methods

In some of the larger industries, a psychiatrist may be employed to grapple with the great amount of human maladjustment which every organization contains, while in the smaller ones this task may be decentralized among executives, managers, and supervisors who have some training in practical psychology as well as a temperament and a warm human understanding nature suited to counseling workers about their problems. Few of the adjustment problems are of sufficient severity to require the services of a psychiatrist. The guidance and counseling movement which has helped so immeasurably in the public schools can be extended and can become equally successful in our industrial system. This, to be sure, requires trained counselors who know when to refer a special case to the psychiatrist, particularly if organic deficiencies are suspected. Usually the difficult problem of the "nervous" worker, thus far given little sympathy or consideration, can in a large measure be solved through the coordinated efforts of those concerned with the organization, direction, and guidance of human resources. There must always be someone in the organization from whom the worker is not constantly taking orders, someone who will listen sympathetically to his problems, study them in light of the various forces that play upon him, and provide him with help in overcoming his difficulties. Such a need is simple but of utmost importance.

If the sole objective of the one concerned with counseling is to increase production rather than to help in the adjustment of the worker to his task and his situation, he has failed, basically, to improve industrial relations. An adequate "philosophy of life" resulting from enlightened church, home, community, or vocational education, especially when this is strengthened by adequate individualized treatment within the plant, helps both workers and supervisors to discount the crises of the moment and to overcome them without loss of emotional balance. To stabilize each worker with such a supporting philosophy is not a superfluous job irrelevant to the business of manufacturing and distributing goods, but one essential to this business. Indeed, once human welfare and happiness are restored to the level of first consideration—a position they should never have lost—the whole field of industrial practices will have moved forward. A socioeconomic program that rests upon any other foundation will inevitably collapse.

"In the final analysis, no matter how big an organization becomes in the aggregate, the individual workers cannot be dehumanized. They will always be there with their human frailties, foibles, and vicissitudes. These cannot be ignored if efficiency is to be maintained and friction avoided."[36]

SUMMARY

The cost of employee maladjustments, when reckoned in terms of human welfare and happiness, is enormous. Changed social and economic conditions have brought with them problems of specialization, dependence, security, and need for status. This is the basis of widespread dissatisfaction among workers in the lower occupational scale. Such a dissatisfaction is ordinarily evidenced by many observable behavior symptoms. The alert foremen and supervisors will recognize these symptoms and make attempts to alleviate the causes when possible.

The causes of maladjustments among workers are many. Some of these lie within the working environment; some in the out-of-work environment; others result from characteristics within the worker. Such causes will vary from concern to concern. The problem of alleviating maladjustments resulting from home and community forces is a complex and difficult one. Attempts by industry to help the maladjusted suffering from such conditions are usually of an indirect nature.

RECOMMENDED READINGS

ANDERSON, V. V.: *Psychiatry in Industry,* Harper & Brothers, New York, 1929.

ASPLEY, JOHN C., and WHITMORE, EUGENE: *The Handbook of Industrial Relations,* The Dartnell Corporation, Chicago, 1944. A good analysis of grievances among industrial workers is presented on pp. 255–272.

BELLOWS, ROGER M.: *Psychology of Personnel in Business and Industry,* Chap. 10, Prentice-Hall, Inc., New York, 1949.

BEVINGTON, S.: *Occupational Misfits,* George Allen & Unwin, Ltd., London, 1933.

BOWLER, E. M., and DAWSON, FRANCES T.: *Counseling Employees,* Prentice-Hall, Inc., New York, 1948.

CALHOUN, R. P.: *Problems in Personnel Administration,* Chap. 14, Harper & Brothers, New York, 1949.

DRAKE, FRANCES S., and DRAKE, CHARLES A.: *A Human Relations Casebook for Executives and Supervisors,* McGraw-Hill Book Company, Inc., New York, 1947.

FISHER, V. E., and HANNA, J. V.: *The Dissatisfied Worker,* The Macmillan Company, New York, 1931.

HAND, THOMAS, HOPPOCK, ROBERT, and ZLATCHIN, P. J.: Job Satisfaction: Researchers of 1944 and 1945, *Occupations,* 1948, 26, 425–431. Thirty-four studies of job satisfaction in the years 1944 to 1945 are reviewed and classified by the factors studied and method of investigation used.

[36] Giberson, Lydia G., Psychiatry in Industry, *Person. J.,* 1936–1937, 15, 95.

HERSEY, R. B.: *Workers Emotions in Shop and Home,* University of Pennsylvania *Press,* Philadelphia, 1932.

HOPPOCK, R., ROBINSON, H. A., and ZLATCHIN, P. J.: Job Satisfaction Researches of 1946–1947, *Occupations,* 1948, 27, 167–175. This is the sixth biennial review of researches on job satisfaction. A bibliography of 49 items is included.

McMURRY, R. N.: *Handling Personality Adjustments in Industry,* Harper & Brothers, New York, 1944.

REYNOLDS, L. G., and SHISTER, J.: *Job Horizons: A Study of Job Satisfaction and Labor Mobility,* Harper & Brothers, New York, 1949. This is the second of a series of reports issued under the auspices of the Labor and Management Center at Yale University.

SUPER, D. E.: *The Dynamics of Vocational Adjustment,* Harper & Brothers, New York, 1942.

THOMASON, C. C.: *Human Relations in Industry,* Prentice-Hall, Inc., New York, 1948.

VITELES, MORRIS: *Industrial Psychology,* Chap. 26, W. W. Norton & Company, New York, 1932.

APPENDIX

BASIC STATISTICAL CONCEPTS

Psychological statistics deal largely with groups of measurements and their relationships. The ages of a group of superior welders may be compared with the ages of a group of inferior welders, or the intelligence of a group of supervisors may be compared with the intelligence of a group of high school teachers, or the dexterity of a group of machinists may be compared with the dexterity of a group of clerical workers. It is more difficult to compare groups of measurements with each other than it is to compare individual measurements with each other. In comparing groups of data, it may be necessary to calculate averages, or deviations from the average, or the reliability of averages, or the reliability of differences between averages, or the relationship between two series of paired data. The following pages will briefly describe these procedures and give illustrative calculations. Teacher assistance and reference books will be necessary for the reader who has had no previous experience with statistics.

THE AVERAGE OR MEAN

Two series of measurements may be compared with each other by calculating the averages of each. For example, the average age of a group of semiskilled workers was found to be thirty-one years, four months, while the average age for a group of skilled workers in the same industry was found to be thirty-eight years, nine months. This permits only a rough comparison, but it is often the only comparison available. The average is obtained by adding all scores or cases and dividing by the number involved. Two calculations are shown below.

Average or Mean: $\frac{\Sigma s}{N}$

Workmen	Production units (x series)	Weekly wage (y series)
A.	120	\$50
B.	123	63
C.	115	47
D.	126	58
E.	136	72
Total	620	\$290
Average	$620/5 = 124$	$290/5 = \$58$

DEVIATIONS FROM THE AVERAGE

To know that a workman is below the average in production is meaningful; but to know how far he is below the average is more meaningful. The distance a measurement is above or below the average is called the *deviation*. Suppose that the average production in a plant is 137 units and a workman produces 125 units. He is said to deviate by 12 units. Even this is not very meaningful until it is compared with the *standard deviation* (S.D.). If the standard deviation is 30 production units, this workman is not so far below the average production after all. Variations above and below an average measurement, however, are usually expressed in units of the standard deviation. This is calculated by squaring all deviations, adding them together, dividing by the number of cases, and then taking the square root of this quotient. The formula for this process is stated $\sqrt{\Sigma d^2/N}$. The standard deviation is sometimes called the *sigma* of a distribution. A measurement translated into a sigma value is called the sigma score or the standard score. A sigma unit always indicates a fixed number of cases above or below the average. For example, 1 sigma below the average is always at the 16th percentile, and 1 sigma above the average is always at the 84th percentile.[1] A sigma score is an indication of the relation of the score to the total distribution. Sigma values are directly comparable with each other. A sigma above the average in one distribution of measurements is exactly equal to a sigma above the average in any other distribution of measurements. Often raw scores are transmuted into sigma values so they can be compared with other scores in other distributions.

Standard Deviation or Sigma: $\sqrt{\Sigma d^2/N}$

Workmen	Deviations		Deviations squared	
	Production units, dx	Weekly wage, dy	Production units, dx^2	Weekly wage, dy^2
A.	−4	−8	16	64
B.	−1	5	1	25
C.	−9	−11	81	121
D.	2	0	4	0
E.	12	14	144	196
Total.	...	....	246	406

$$\text{S.D.}_x = \sqrt{246/5} = \sqrt{49} = 7$$
$$\text{S.D.}_y = \sqrt{406/5} = \sqrt{81} = 9$$

A score is translated into sigma value by subtracting the average (or the score from the average depending on which is larger) and dividing by the sigma. Using the preceding illustrations, workman E's weekly wage has a sigma value of 1.55 $[(72 - 58) \div 9 = 1.55]$. (Data calculated from preceding table.)

---

[1] The zero sigma is, of course, at the 50th percentile.

RELIABILITY OF THE AVERAGE

It is often necessary to calculate how typical a group of data are, that is, the degree to which the data are true samples of a larger group of data. For example, during the last war a group of women punch-press operators averaged within 3 per cent as much production as did the men operators whom they replaced. In comparing the average production of the two groups, it is important to know how typical the data are. What would probably be the result if a much larger group of both men and women workers were compared? In other words, what is the *standard error of the average* (S.E.)? This is calculated by dividing the standard deviation of a distribution by the square root of the number involved. The formula is $\sigma/\sqrt{N - 1}$. This means that there are 68 chances in 100 that the true average will fall within the plus or minus range of the standard error. If an average is 60 and the standard error is 10, the chances are 68 in 100 that the true average is between 50 and 70 (60 ± 10). The smaller the standard error, the closer the obtained average is to the true average. A small standard deviation and a large number of cases will produce a small standard error.

Standard Error of an Average: $\dfrac{\sigma}{\sqrt{N - 1}}$

$$S.E._{\cdot x} = \frac{7}{\sqrt{5 - 1}} = 3.5 \qquad S.E._{\cdot y} = \frac{9}{\sqrt{5 - 1}} = 4.5$$

(Data are taken from preceding calculations.)

This means that there are 68 chances in 100 that the true average production is between 120.5 units and 127.5 units (124 ± 3.5), and the true average wage is between \$53.50 and \$62.50 (\$58.00 ± \$4.50).

THE COEFFICIENT OF CORRELATION

Often the relation between two series of measurements is not accurately indicated by comparing the averages, or the deviations, or even individual measurements. The averages and the sigmas may be the same for two distributions of measurements, and yet there may be little relation between them. In fact, a group of applicants may have the same average score on two tests, the standard deviations may be the same, and yet the scores made on one test may have zero predictive value on the other. The coefficient of correlation (symbol r) is a statistical calculation which indicates the degree to which a score in one distribution is predictive of the score in another distribution. A perfect relation between two series of data (that is, when a score in one series indicates the score in the other series without error) is indicated by a coefficient of correlation of 1.00 (or −1.00 if the relationship is inverse). Most relationships are less than perfect and are indicated by coefficients of correlation of less than 1.00. If there is but a chance relation between two series of measurements, the correlation is zero. The forecasting efficiency of coefficients of correlation does not increase arithmetically from zero to 1.00. A correlation of .50 is not half as high in terms of forecasting efficiency as a correlation of 1.00. In fact, it is only 13 per cent better than chance, while 1.00 eliminates chance entirely. When a correlation is .50, the error of forecast is not reduced by half. To reduce the error of forecast by 50 per cent it is necessary to have a coefficient of correlation of .87 (or −.87). This means that when a correlation is below .90 it is of doubtful value in forecasting individual scores. However, correlations even below .30 (with a forecast value about 5 per cent better than chance) are valuable in showing tendencies, or limited relationships.

The calculation of a coefficient of correlation, while complicated, is not too difficult when the calculations explained above are understood. A simple procedure is to divide the sum of the products of the deviations of the two series, by the product of the two standard deviations, times the number of cases. The formula for this is stated below. Using the data given above, the coefficient of correlation is calculated as follows:

Coefficient of Correlation: $\frac{\Sigma d_x \cdot d_y}{\mathcal{N} \cdot (\sigma_x \cdot \sigma_y)}$

	Production Deviations Times Wage Deviations ($dx \cdot dy$)
A	32
B	−5
C	99
D	0
E	168
Total	294

$$r = \frac{294}{5(7 \times 9)} = .93$$

(Data taken from preceding tables.)

SIGNIFICANCE OF A DIFFERENCE BETWEEN AVERAGES

A large difference between two averages may or may not be a true one. For example, the difference between the average production in the example given above and the average production of another group of workmen is 10 production units. (The average production of the second group was 134.) By calculation this is not sufficiently significant to be considered a true difference. (It is significant only at the 83 per cent level of confidence.) The degree of significance of a difference between two averages is calculated by first obtaining the standard error of the difference. This is the square root of the sum of the squares of the standard deviations of the two averages. The formula for this calculation is $\sqrt{\sigma^2_{m1} + \sigma^2_{m2}}$. Then, the difference between the averages is divided by the standard error of the difference. This quotient is called the "critical ratio" (C.R.). It indicates the chances that the true difference is greater than zero. A critical ratio of 2 indicates 98 chances in 100 that the real difference is greater than zero. This is sometimes expressed as "the 98 per cent level of confidence." In psychology, it is customary to consider a difference to be significant only if the critical ratio is at least 2.5 or at the 99.4 level of confidence. When the critical ratio is 3.0 or higher, the difference is considered to be certain.

Standard Error of a Difference between Two Averages: $\sqrt{\sigma^2_{m1} + \sigma^2_{m2}}$.

The first average is 124 with an S.D. of 7; the second average is 134 with an S.D. of 8. The difference in averages is 10. Therefore, the standard error of the differences is $\sqrt{49 + 64} = \sqrt{113} = 10.6$.

Critical ratio: $\frac{\text{diff.}}{\text{S.E.}_{\text{diff.}}}$ or $\frac{M_1 - M_2}{\sqrt{\sigma^2_{m1} + \sigma^2_{m2}}}$

$\frac{10}{10.6} = .94$ or the 83 per cent level of confidence.[2]

Illustrative Calculations

Workmen $N - 10$	Intelligence test scores (x series)	Production units (y series)	Deviations		Deviations squared		Deviations multiplied
			dx	dy	dx^2	dy^2	$dx \cdot dy$
Jones	48	109	−14	−20	196	400	280
Bennett	73	119	9	−10	81	100	−90
Smith	52	125	−10	− 4	100	16	40
Courtney	50	127	−12	− 2	144	4	24
Blake	49	130	−13	1	169	1	−26
Arthur	79	132	17	3	289	9	51
Mays	65	132	3	3	9	9	9
Brown	68	136	6	7	36	49	42
Johnson	70	138	8	8	64	64	64
Clark	66	142	4	13	16	169	52
Total	620	1,290	....	....	1,104	821	446
Average	62	129					
S.E.	3.6	3.0					
S.D.	.....	.....	....	....	10.9	9.0	
Coefficient of correlation	$\frac{446}{10(10.9 \cdot 9.0)} = \frac{446}{981} = .44$*						

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* See textbooks in statistics for tables giving prediction value of various coefficient of correlation values.

[2] See textbooks in statistics for tables giving confidence levels for various CR values.

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